CONTRACT DOCUMENTS

SOUTH DAVIS SEWER DISTRICT

North Plant Upgrade Project

Technical Specifications
Volume II

April 2024

REGISTERED PROFESSIONAL ENGINEER
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AQUA ENGINEERING

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SECTION 011000 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Construction Documents
4. Phased construction
5. Plant operation during construction
6. Construction and schedule constraints
7. Phased construction
8. Sequence of construction
9. Owner selected equipment
10. Access to site.
11. Coordination with occupants.
12. Work restrictions.
13. Specification and drawing conventions.
14. Miscellaneous provisions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: **South Davis Sewer District North Plant Upgrade Project**

1. Project Location: 1800 West 1200 North, West Bountiful, UT 84087

B. Owner: South Davis Sewer District – Matt Myers (General Manager) (801)232-7017

Engineers: Aqua Engineering – Brad Rasmussen (801)299-1240, Edgar Teran (801)683-3771

Engineers have been engaged for this Project to provide architectural and engineering services.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The following list has been furnished for the convenience of the Contractor and shall not be considered as representing all Work required in the Contract Documents. The contractor shall not take advantage of any errors or omissions in this listing and shall report any discrepancies or

questionable items to the Engineer for clarification. The Work of Project is defined by the Contract Documents and consists of the following:

1. The Mobilization of all equipment, labor, tools, and materials to and from the project site.
2. Site demolition and removal of existing equipment and/or infrastructure as indicated in the Contract Documents.
3. Construction of a new Headworks building that will replace the existing headworks building. Furnish and install influent screens and other associated components including dry pit submersible pumps. Install chemical tanks and chemical feed system.
4. Construct a new Primary Clarifier and install all associated structural, gates, mechanical, piping, and electrical components.
5. Construct a Moving Bed Biofilm Reactor (MBBR) tank, install associated screens, aeration piping and equipment, and add media. The tank will operate around 20-ft surface water depth. The MBBR will include medium/coarse bubble air grid and cylindrical media screens.
6. Construct a Snail Trap structure and install associated grit vortex mechanism, gates and associated equipment. The concrete structure is part of the MBBR tank structure.
7. Construct a concrete Blower Building attached to the MBBR tank structure. The building will house turbo blowers that will aerate the MBBR tank described above. The Blower Building will house a pump and grit classifier.
8. Construct a new Administration building and demolish the existing building to make room for the new digester.
9. Construct a new Digester Building and Digester Tank and install associated process piping, pumps, boilers, and tank mixing equipment. Digester Building includes a new electrical room.
10. Construct a new Dewatering Building and install screw press system and other associated components including polymer mixing/injection skids. Dewatering building includes a new electrical room.
11. Sand blast and paint the existing Primary Clarifiers (1, 2, and 3) mechanisms. Contractor shall always maintain two or three clarifiers in operation during this task.
12. Sand blast and paint the gravity thickener mechanism. Contractor shall coordinate shut down and bypass pump during this task.
13. Sand blast and paint the existing Final Clarifiers (1, 2, 3, and 4) mechanisms. Contractor shall always maintain three or four clarifiers in operation during this task.
14. Remove and replace distribution arms from 3 of 4 existing trickling filters. Contractor to inspect spacer plate and anchor bolts on the spacer plate, and clean existing gasket seal. Contractor shall install new gasket seal on trickling filter 3.
15. Construct a new submersible pump station that contains trickling filter recycle pumps along with pumps that feed the new MBBR.
16. Remove and dispose of piping in the existing Raw Sludge Pump Station. Remove and salvage an existing Gorman Rupp pump and Piston Pump. Install new process piping and two new Gorman Rupp pumps.

17. Remove and dispose of piping in the existing Digester Control Building. Remove and Salvage two existing piston pumps located in the basement. Install new process piping and two new progressive cavity pumps.

18. Install a new effluent line

19. Construct a new electrical service for the facility including main switchgear, generator, automatic transfer switch, power distribution duct banks and other equipment to facilitate power distribution to all existing and new buildings

20. Construct a new fiberoptic network for an upgraded SCADA system to include expansion to all existing and new buildings at the facility. Installation of SCADA and Instrumentation systems to support the control system as required in the contract documents.

21. All other civil, yard piping, mechanical, and electrical work included in the Contract Documents.

22. All other civil, yard piping, mechanical, and electrical work included in the Contract Documents.

23. Testing and Startup and Commissioning as described in Section 017500 – Commissioning.

List above is intended to provide an overview of the major project components and does not include all work described in Contract Documents.

B. Type of Contract.

1. Project will be constructed under a single prime contract.

1.4 CONSTRUCTION DOCUMENTS

A. The Contractor may obtain copies of the construction documents as directed in the Instruction to Bidders in Volume 1, "Notice and Invitation to Bidders." Electronic copies of the existing plant drawings will be available to the successful Contractor through the same means. Note that only limited "record drawings" or "as-constructed drawings" for previous on-site construction projects are available.

1.5 PHASED CONSTRUCTION

A. The Work shall be conducted in accordance with an approved Contractor Schedule.

1. It is expected that the project will consist of several aspects that may be completed simultaneously or in succession. Completion of the project requires coordination between the Plant staff and the Contractor as the plant needs to be operational during the construction. Some aspects may require bypass pumping, or advanced preparation by staff to incorporate new structures/process, while others may be coordinated during periods of low flow with operating staff.

2. The Work shall commence simultaneously with the Notice to Proceed and be substantially complete and ready for occupancy within the timeframe noted in the Agreement upon issuance of Notice to Proceed.

B. Critical Tie-Ins:

1. Influent Pipe Line Tie-In to New Headworks

    a. In order to divert the flow into the new headworks the contract will need to build a "doghouse" style manhole over top the two influent truck lines. Once the headworks is constructed and all equipment has been tested and started up the lines in the manholes can be cut and capped as to send all the flow into the new headworks

2. Tie-In to new Effluent Pipeline.
    a. In order to tie into the new effluent pipeline, the contractor can bypass pump out of the effluent box. The effluent box has an existing gate that would stop flow running out of the existing effluent pipe. Bypass pumping can be used to send the flow out into the state canal.

3. MBBR Pump Station Tie-In
    a. The MBBR Pump Station will replace Pump Station #2. The MBBR pump station will be constructed in between the Trickling Filters. The effluent lines from the Trickling Filters will need to tie into the MBBR pump station. Bypass pumping will be required during this tie-in.

C. The Contractor's Schedule shall include completion dates. It shall also be coordinated with the sequencing plan. It is anticipated and expected that work will begin with the Notice to Proceed.

1.6 CONSTRUCTION AND SCHEDULE CONSTRAINTS

1. Construction of the Work will require short disruptions of individual or multiple processes at the existing wastewater treatment facility to make critical connections or replace existing pipelines and infrastructure. Contractor shall schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified. Contractor shall provide temporary facilities, bypass systems, or other approved means to ensure continuous operation of plant processes to meet system operational and emergency demands.
2. Contractor shall notify Engineer and Owner in writing at least 14 working days in advance of any operation that will disrupt Owner's facilities or operations or any required shutdown. Prior to removing any portion of the existing facilities, submit and obtain Engineer and Owner approval for all submittals required to construct the proposed improvements.
3. Clearly demonstrate in the CPM Schedule and other submittals, to the satisfaction of the Owner and the Engineer, the Contractor's ability to complete the Work requiring an interruption of service (shutdown work) within the allowable duration.
4. If the Contractor does not clearly demonstrate the ability to complete the shutdown work in the CPM Schedule proposed during a shutdown period, the Owner reserves the right to limit the scope of the shutdown work which the Contractor may undertake.
5. Opportunities for shutdown of existing WRF individual or multiple processes will be limited to periods of low plant flow and limited in duration. The periods of daily low flows are typical associated with hours between 10:00 PM and 6:00 AM. It is noted that there is a degree of variability in daily low flow conditions due to several factors (time of the year, weather conditions, special events etc.) and required and appropriate contingencies shall be in place. Due to the nature of wastewater treatment, there are some processes for which no shutdown is possible.

1.7 SEQUENCE OF CONSTRUCTION

A. The Contractor shall prepare and submit a phasing/sequencing plan. The proposed phasing plan will be evaluated by the Engineer and the Owner prior to approval. When developing the phasing plan, the contractor shall evaluate other construction factors such as the requirement to keep the plant operational at all times and provide adequate access for plant operations and maintenance.

B. As noted, there may be several local tie-ins and shutdowns to bring on-line new equipment and infrastructure. The contractor shall coordinate ahead of time local tie-ins and shutdowns with the Plant staff and will be responsible for planning and coordinating all aspects of the work. The Contractor is required to submit a detailed work plan for each shutdown or tie-in event. A test shutdown shall be completed at least 14 days prior to actual shutdown(s).

C. While localized shutdowns or bypassing may be required, the Plant shall continue to process influent flows and meet the current Water Discharge Permit (available upon request). It shall be the responsibility of the Contractor to ensure that each process maintains operability throughout the construction. All bypass pumping shall be provided with complete redundancy. The Contractor shall bear any fines associated with the failure to meet Water Discharge Permit requirements due to construction activities. The Contractor shall also be held liable for violations of applicable permits due to construction activities. The Contractor shall be held liable for damages resulting from sewage spills caused by improperly performed shutdowns and bypasses.

D. For each proposed bypass operation, the Contractor shall submit a bypass plan in accordance with Section 020960 of the Specifications. Prior to any bypassing, the plan must be approved by the Owner and Engineer. The Contractor shall be responsible for clean-up and repair of any damage caused during bypassing.

1.8 ACCESS TO SITE

A. General: Contractor shall have full use of Project site, defined as the limits of construction, for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors for work on the site or facilities. Owner will inform the contractor of areas that are essential for facility operation which shall not be disturbed, blocked, or impacted by the construction efforts.

B. Use of Site: Limit use of Project site to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

a. Schedule deliveries to minimize use of driveways and entrances by construction operations.

1.9 OCCUPANTS

A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
2. Provide not less than 72 hours notice to Owner of activities that will affect Owner's operations.

B. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

1. Owner will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
3. Before limited Owner occupancy, mechanical and electrical systems shall be Substantially Complete, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.10 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 5:00 p.m., Monday through Friday, unless otherwise indicated and/or agreed with the Owner all in accordance with General Conditions.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify Owner not less than two days in advance of proposed utility interruptions.

D. Noise, Vibration, and Odors: Coordinate with Owner all operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy.

1. Notify Owner not less than two days in advance of proposed disruptive operations.

E. Smoking requirements are to comply with State law.

1.11 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. General and Special Conditions: Requirements of General and Special conditions provided in Volume I of Contract Documents apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations and scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

END OF SECTION 011000

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. Coordination drawings.
2. Requests for Information (RFIs).
3. Project Web site.
4. Project meetings.

1.2 DEFINITIONS

A. RFI: Request from Owner, Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.

1.3 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.

4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.4 REQUESTS FOR INFORMATION (RFIs)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Engineer will return RFIs submitted to Engineer by other entities controlled by Contractor with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Engineer.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Engineer.

D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven (7) working days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. will be considered as received the following working day.

1. The following RFIs will be returned without action:

a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for coordination information already indicated in the Contract Documents.
d. Requests for adjustments in the Contract Time or the Contract Sum.

e. Requests for interpretation of Engineer's actions on submittals.
f. Incomplete RFIs or inaccurately prepared RFIs.

2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.
3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to General Condition requirements.

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer and Construction Manager in writing within 10 (10) days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Software log with not less than the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Engineer.
4. RFI number including RFIs that were dropped and not submitted.
5. RFI description.
6. Date the RFI was submitted.
7. Date Engineer's response was received.

F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven (7) days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.5 PROJECT MEETINGS

A. General: Construction Manager will schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, Construction Manager, and Engineer, within three (3) days of the meeting.

B. Preconstruction Conference: Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than fifteen (15) days after execution of the Agreement.

1. Attendees: Authorized representatives of Owner , Construction Manager, Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Tentative construction schedule.
    b. Phasing.
    c. Critical work sequencing and long-lead items.
    d. Designation of key personnel and their duties.
    e. Procedures for processing field decisions and Change Orders.
    f. Procedures for RFIs.
    g. Procedures for testing and inspecting.
    h. Procedures for processing Applications for Payment.
    i. Distribution of the Contract Documents.
    j. Submittal procedures.
    k. Preparation of record documents.
    l. Use of the premises and existing building.
    m. Work restrictions.
    n. Working hours.
    o. Owner's occupancy requirements.
    p. Responsibility for temporary facilities and controls.
    q. Procedures for moisture and mold control.
    r. Procedures for disruptions and shutdowns.
    s. Construction waste management and recycling.
    t. Parking availability.
    u. Office, work, and storage areas.
    v. Equipment deliveries and priorities.
    w. First aid.
    x. Security.
    y. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Engineer, Construction Manager of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

    a. Contract Documents.
    b. Options.
    c. Related RFIs.
    d. Related Change Orders.
    e. Purchases.

f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility problems.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written instructions.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Construction Manager will conduct progress meetings at weekly intervals.

1. Attendees: In addition to representatives of Owner , Construction Manager, and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Status of documentation.
5) Deliveries.
6) Off-site fabrication.
7) Access.
8) Site utilization.
9) Temporary facilities and controls.
10) Progress cleaning.
11) Quality and work standards.
12) Status of correction of deficient items.
13) Field observations.
14) Status of RFIs.
15) Status of proposal requests.
16) Pending changes.
17) Status of Change Orders.
18) Pending claims and disputes.
19) Documentation of information for payment requests.

3. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

    a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013130 - SAFETY

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor's safety program shall conform to the requirements specified in the General Conditions.

B. This specification provides general guidance for site safety and a site safety program.

1.2 DEFINITIONS

A. For the purposes of this Section, an "active construction area" is any area where construction activities are occurring or construction activities could be considered a potential hazard to people.

B. A "Designated Safety Officer" or "Safety Representative" for the purposes of this Contract, means anyone who is capable of identifying the existing and predictable hazards in the areas surrounding a construction project or those working conditions at a construction project that are unsanitary or dangerous to employees. A "Designated Safety Officer" has the authority to make prompt corrective measures to eliminate those hazards.

C. For the purposes of this Section, a "classified area" represents any area within the classified boundary or envelope of an active wastewater treatment process basin, channel, or other facility. A table summarizing the classified areas present within the boundaries and scope of this project is provided in paragraph 1.4 of this Section.

1.3 SUBMITTALS

A. Demonstrate compliance action with the stipulations of Occupational Safety and Health Administration (OSHA), Mine Safety and Health Administration (MSHA), and other applicable local, state, and federal safety requirements by submitting to Engineer a copy of all safety plans, programs, and permits. Such plans and programs shall include, but are not limited to:

1. Hazard Analysis Prior to Major Activities (job safety analysis, JSA).
2. Emergency Plan.
3. Rigging and Hoisting Plans.
4. Excavation and Trenching Plans.
5. Respiratory Protection Program.
6. Fire Protection Plan.
7. Confined Space Entry Program.
8. Explosives Handling and Storage.
9. Confined Space Entry Program.
10. Electrical Safety (drop cords, temporary power, GFCI's, etc.)
11. Lock Out/Tag Out.
12. Fall Protection.
13. Heavy Equipment Operations.
14. Burning and Welding Operations.
15. Training Plan.
16. Tunneling/Underground/Jacking/Boring Operations.
17. Project Site Rules and Regulations (hazard protection plan).

18. Material Handling (storage-disposal).
19. Fuel Storage and Refueling.
20. Hazard Communication/Right to Know.
21. Subcontractor Requirements.
22. Ventilation.
23. Personal Protective Equipment (hearing, eye, face).
24. Power Transmission/Distribution (temporary and/or permanent).
25. Traffic Control.
26. Environmental Controls.
27. Safety Meetings.
28. Spill Control Plan.
29. First Aid Facilities.

B. Engineer's receipt of safety plans or programs will not relieve Contractor in any way from the full and complete responsibility for safety and training of its personnel, and the onsite personnel of Owner, Engineer, and other visitors to areas of active construction areas. On a daily basis, inform Engineer of changes to the boundaries of the active construction areas.

C. Be responsible for safety training all personnel who will have access to the active construction areas to meet state, federal, local and Contractor requirements. Maintain reasonable, regularly scheduled training sessions in mutually accessible facilities through entire Contract. Training costs for all personnel and visitors, except those costs associated with training personnel of Contractor, subcontractors, suppliers, and visitors will be considered incidental to other lump-sum portions of the Work and no additional compensation for such training will be provided.

D. Safety Program Requirements:
   1. Safety Representative Requirements:
      a. Assign a full-time Safety Representative.
      b. The Safety Representative's duties and responsibilities will be hazard recognition, accidents prevention, new employee orientation (including subcontractors), and the maintaining and supervising of safety precautions and program. This person shall have no other duties. The Safety Representative or a qualified and approved deputy shall be onsite at all times while Work is ongoing.
      c. Qualifications of the Safety Representative and assigned deputies shall be submitted to Engineer for review. Acceptance of their qualifications by Engineer is required prior to the start of any activity on the Project. The Safety Representative will, as a minimum, meet the requirements of regulations per OSHA.
   2. Hazardous Substances:
      a. Provide Engineer with a list of all hazardous substances anticipated to be brought on-site.
      b. Maintain on site Material Safety Data Sheets (MSDS) prior to arrival of any hazardous substances on the Project.
      c. Use storage area(s) as outlined in the spill control plan.
   3. Job Safety Analysis (JSA):
      a. Outline the sequence of the Work, equipment to be used, identify hazards that may exist or may be created and what procedures and/or safety equipment will be used to eliminate or reduce these hazards. A Scope of Work JSA shall be prepared and provided to the Engineer prior to the start of unusual, hazardous, or high risk

potential activities on the Project. The name of the competent person assigned to this activity will be included on the JSA.

b. Complete a JSA for any activity, which may be of an unusual nature or involves unique hazards.

4. Reports

a. Provide to Engineer copies of Contractor's and subcontractor's:

1) First aid, recordable, lost time and near miss, monthly logs.

2) OSHA 200 injury log (annually).

3) Safety meeting reports and topics (weekly).

4) List of competent persons as required by OSHA and the Project Health and Safety Manual for each required task and their qualification as such.

5) Injury and accident reports will be submitted to Engineer within 24 hours of any incident. **Immediate** notification to Engineer of an accident is **required**. Full cooperation with Engineer in accident investigation is required.

b. Conduct weekly safety inspections. Corrective actions shall be taken within 24 hours to address all deficiencies identified during inspections. Deficiency reports shall be prepared and submitted to Engineer within 48 hours indicating corrective actions taken. Failure to comply with required corrective measures identified in the safety inspection will result in the delayed signing of the monthly application for progress payment by Engineer.

c. Provide Engineer with a report of any periodic audit of Contractor's safety performance and/or records.

1.4 CLASSIFIED AREAS

A. The Site is an active wastewater treatment plant that must remain operational and online at all times. Consequently, construction activities for this project will involve working near process basins and equipment that must remain online and operational. In addition to the usual hazards of open, deep basins and equipment/machinery that is actively operating, many of these basins and structures are considered classified zones (per NFPA 820) with potential hazards for fire and explosions due to the presence of explosive gases associated with wastewater.

B. Contractor shall take all additional precautions necessary when working within the classified zones and envelopes in these areas to prevent sparks, open flames, ignitions, and reduce the risk of fire or explosion. Precautions include but are not limited to: reviewing classified areas with all workers and subcontractors as part of the regular safety meetings and site orientation; providing proper PPE for workers entering classified areas; avoid using electrical tools, plugs, extension cords, welding equipment, open flames/heaters, and other potential sources for sparks or ignition within the classified envelopes; and following all guidelines and recommendations provided in NFPA and OSHA for working in classified areas,

C. Refer to Electrical Site Layout Drawings for classified areas.

END OF SECTION 013130

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's construction schedule.
2. Construction schedule updating reports.
3. Daily construction reports.
4. Site condition reports.

1.2 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.

1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
2. PDF electronic file.
3. Two (2) paper copies.

B. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.

E. Construction Schedule Updating Reports: Submit with Applications for Payment.

F. Daily Construction Reports: Submit at weekly intervals.

G. Site Condition Reports: Submit at time of discovery of differing conditions.

1.4 COORDINATION

A. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Schedule shall be prepared in accordance with Article 6 of the General Conditions.

B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of final completion.

C. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

D. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and Contract Time.

E. Recovery Schedule: When periodic update indicates the Work is fourteen (14) or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule.

2.2 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events.
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Work Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: Update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Engineer, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013300 – CONTRACTOR SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals. The Contractor shall coordinate the submittal requirements in this section with those given in the General and Special Conditions of Volume I, “Bid and Contract Documents.”

B. Related Requirements:

1. Section 013200 “Construction Progress Documentation” for submitting schedules and reports, including Contractor's construction schedule.
2. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action.

B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.3 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.

B. Construction Schedule: Within fourteen (14) days after the date of Notice to Proceed, the Contractor shall submit a construction schedule providing the starting and completion dates of the various stages of the Work. The Contractor shall be prepared to discuss its construction schedule at the pre-construction conference.

C. Schedule of Values or lump sum price breakdown: Within fourteen (14) days after the date of Notice to Proceed, the Contractor shall submit a schedule of values or lump sum price breakdown for progress payment purposes.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Engineer's Digital Data Files: Electronic copies of digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.

1. Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings.

a. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
b. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Engineer.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

a. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow fifteen (15) days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow fifteen (15) days for review of each resubmittal.

D. Paper Submittals: Place a permanent label or title block on each submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Include the following information for processing and recording action taken:

a. Project name.
b. Date.
c. Name of Engineer.
d. Name of Construction Manager.
e. Name of Contractor.
f. Name of subcontractor.
g. Name of supplier.
h. Name of manufacturer.

i. Submittal number or other unique identifier, including revision identifier.

1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

j. Number and title of appropriate Specification Section.
k. Drawing number and detail references, as appropriate.
l. Location(s) where product is to be installed, as appropriate.
m. Other necessary identification.

3. Submittal Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.

4. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return without review submittals received from sources other than Contractor.

a. Transmittal Form for Paper Submittals: Use facsimile of sample form included in Project Manual.
b. Transmittal Form for Paper Submittals: Provide locations on form for the following information:

1) Project name.
2) Date.
3) Destination (To:).
4) Source (From:).
5) Name and address of Engineer.
6) Name of Construction Manager.
7) Name of Contractor.
8) Name of firm or entity that prepared submittal.
9) Names of subcontractor, manufacturer, and supplier.
10) Category and type of submittal.
11) Submittal purpose and description.
12) Specification Section number and title.
13) Specification paragraph number or drawing designation and generic name for each of multiple items.
14) Drawing number and detail references, as appropriate.
15) Indication of full or partial submittal.
16) Transmittal number.
17) Submittal and transmittal distribution record.
18) Remarks.
19) Signature of transmitter.

E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner**,** containing the following information:

    a. Project name.
    b. Date.
    c. Name and address of Engineer.
    d. Name of Construction Manager.
    e. Name of Contractor.
    f. Name of firm or entity that prepared submittal.
    g. Names of subcontractor, manufacturer, and supplier.
    h. Category and type of submittal.
    i. Submittal purpose and description.
    j. Specification Section number and title.
    k. Specification paragraph number or drawing designation and generic name for each of multiple items.
    l. Drawing number and detail references, as appropriate.
    m. Location(s) where product is to be installed, as appropriate.
    n. Related physical samples submitted directly.
    o. Indication of full or partial submittal.
    p. Transmittal number.
    q. Submittal and transmittal distribution record.
    r. Other necessary identification.
    s. Remarks.

5. Metadata: Include the following information as keywords in the electronic submittal file metadata:

    a. Project name.
    b. Number and title of appropriate Specification Section.
    c. Manufacturer name.
    d. Product name.

F. Options: Identify options requiring selection by Engineer.

G. Deviations: Identify deviations from the Contract Documents on submittals.

H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.

2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements:

1. Action Submittals: Submit one (1) electronic copy and/or one (1) hard copy (if requested by the City) of each submittal unless otherwise indicated.
2. Informational Submittals: Submit one (1) electronic copy and/or one (1) hard copy (if requested by the City) of each submittal unless otherwise indicated. Engineer will not return copies.
3. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

    a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
    b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

    a. Wiring diagrams showing factory-installed wiring.
    b. Printed performance curves.
    c. Operational range diagrams.
    d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

    a. Identification of products.
    b. Schedules.
    c. Compliance with specified standards.
    d. Notation of coordination requirements.
    e. Notation of dimensions established by field measurement.
    f. Relationship and attachment to adjoining construction clearly indicated.
    g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.
    b. Product name and name of manufacturer.
    c. Sample source.
    d. Number and title of applicable Specification Section.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.

b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

   a. Number of Samples: Submit two (2) full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

   a. Number of Samples: Submit two (2) sets of Samples. Engineer will retain one (1) Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.

      1) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

   1. Submit product schedule in the following format:

      a. Four (4) paper copies of product schedule or list unless otherwise indicated. Engineer will return three (3) copies.

F. Coordination Drawings Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."

G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."

H. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."

I. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."

J. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of engineers and owners, and other information specified.

L. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

M. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

N. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

O. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

P. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

Q. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

R. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

S. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.

T. Schedule of Tests and Inspections: Comply with requirements specified in Section 014000 "Quality Requirements."

U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

W. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit three (3) paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents. In the case of shop drawings, each sheet shall be so dated, signed and certified.

3.2 ENGINEER'S ACTION

A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action, as follows:

1. "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED" will require no formal revision and resubmission.

2. "REVISE AND RESUBMIT" or "REJECTED" will require the Contractor to revise said submittal and shall resubmit the required number of copies of said revised submittal to the Engineer.

C. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

F. Fabrication of an item shall commence only after the Engineer has reviewed the submittal and returned copies to the Contractor marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED". Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
2. Requirements for Contractor to provide quality-assurance and -control services required by Engineer, Owner, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.
3. Specific test and inspection requirements are not specified in this Section.

1.2 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer or Construction Manager.

C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five (5) previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.3 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

B. In instances where a conflict arises between standards and/or between the Technical Specifications and the Design Drawings, the more stringent standard or requirement shall govern at the discretion of Owner and Engineer.

C. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.4 INFORMATIONAL SUBMITTALS

A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Engineer.
2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Engineer.

B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized Authority.

1.5 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

B. Manufacturer's Field Reports: Prepare written information documenting tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
5. Other required items indicated in individual Specification Sections.

C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.6 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Manufacturer's Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.

b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
d. When testing is complete, remove test specimens, assemblies, and mockups, and laboratory mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, through Construction Manager, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Engineer or Construction Manager.
2. Notify Engineer and Construction Manager seven (7) days in advance of dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Engineer's and Construction Manager's approval of mockups before starting work, fabrication, or construction.

a. Allow seven (7) days for initial review and each re-review of each mockup.

5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed unless otherwise indicated.

K. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections.

1.7 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services. It is the Contractor’s responsibility to schedule the testing provided by such agencies.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

2. Notify testing agencies at least twenty-four (24) hours in advance of time when Work that requires testing or inspecting will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a manufacturer's representative to observe and inspect the Work. Manufacturer's representative's services include examination of substrates and conditions, verification of materials, inspection of completed portions of the Work, and submittal of written reports.

D. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

E. Testing Agency Responsibilities: Cooperate with Engineer, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Engineer, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.

6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.8 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections and in Statement of Special Inspections included in the Contract Documents (Drawings), and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
2. Notifying Engineer, Construction Manager, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer, through Construction Manager, with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and re-inspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's and Construction Manager's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014120 - PERMITS

PART 1 - GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

A. Obtain permits required for the execution of Work in accordance with the Contract Documents. Provide copies of these permits to Owner.

B. The intent of this Section is to furnish the known list of required permits for the Work under the Contract Documents. **Contractor is responsible for determining and verifying the extent of all permits required and for obtaining such permits.**

C. In the Bid Price, include costs for obtaining all necessary permits, including application fees and other costs, and the costs of complying with the conditions of all permits. Any fees listed in this section are estimates and are for information only. Verify and pay all actual fees.

D. Within 30 Days of the Limited Notice to Proceed, submit a list of all permits and licenses to be obtained, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

1.2 SUMMARY OF PERMITS TO BE OBTAINED BY CONTRACTOR

A. Obtain the following permits. Submit copies of these permits to Engineer and maintain copies on-site. Comply with all conditions of the permits and pay all applicable fees. Types of permits that may be required include:

1. SWPPP
2. Any required construction permits from City, County, or State agencies
3. Permits for road construction
4. Permits for transport of equipment and materials to/from the site.
5. Permits for disposal of any debris or demolition materials (as needed)
6. Permits required for environmental protection including dewatering and discharging of waters.
7. Permits for noise or pollution control as required.
8. Any temporary AQMD permits associated with construction efforts.

1.3 SUMMARY OF PERMITS OBTAINED BY OWNER

A. Owner will obtain the following permits:

1. Updated NPDES permit
2. Recycled water permit
3. Updated AQMD permit for plant operations

1.4 NPDES PERMIT

The plant must comply with the current NPDES permit requirements at all time and, accordingly, all construction activity including tie-ins, downtime, demolition, startup, etcetera, must be coordinated with operators to ensure the plant continues to operate as required. A copy of the current NPDES permit is available upon request.

END OF SECTION

SECTION 014200 – ABREVIATIONS AND REFERENCE STANDARDS

PART 1 - GENERAL

1.1 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

D. All work specified herein shall conform to or exceed the requirements of the referenced specifications, codes and standards to the extent that the provisions of such documents are not in conflict with the requirements of these Specifications.

E. References herein to "Building Code" shall mean the International Building Code (IBC) of the International Code Council (ICC). The 2015 edition of the code, as approved and adopted by the agency having jurisdiction, including all addenda, modifications, amendments or other lawful changes thereto, shall apply to the Work.

F. In case of conflict between codes, reference standards, drawings and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and directions prior to ordering or providing any materials or labor. The Contractor shall bid the most stringent requirements.

G. References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

H. References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

AA	Aluminum Association
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute (Formerly: ACI International)
ACPA	American Concrete Pipe Association
AGA	American Gas Association
AGC	Associated General Contractors
AHRI	Air-Conditioning, Heating, and Refrigeration Institute (The)
AI	Asphalt Institute

AIA	American Institute of Architects (The)
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
APA	APA - The Engineered Wood Association
APA	Architectural Precast Association
API	American Petroleum Institute
APWA	American Public Works Association
ASA	Acoustical Society of America
ASAE	American Society of Agriculture Engineer
ASCE	American Society of Civil Engineers
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASLE	American Society of Lubricating Engineers
ASME	American Society of Mechanical Engineers
ASQC	American Society for Quality Control
ASSE	American Society of Safety Engineers (The)
ASSE	American Society of Sanitary Engineering
ASTM	American Society for Testing and Materials International
ATIS	Alliance for Telecommunications Industry Solutions
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association (The)
BOCA	BOCA (Building Officials and Code Administrators International Inc.)
CDA	Copper Development Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturers Institute
CMA	Concrete Masonry Association
CPA	Composite Panel Association
CRSI	Concrete Reinforcing Steel Institute
DASMA	Door and Access Systems Manufacturers Association
DHI	Door and Hardware Institute
ETL	Electrical Test Laboratories
GA	Gypsum Association
GANA	Glass Association of North America
HI	Hydraulic Institute
HMMA	Hollow Metal Manufacturers Association (See NAAMM)
HPVA	Hardwood Plywood & Veneer Association
ICBO	International Conference of Building Officials (See ICC)
ICC	International Code Council
ICEA	Insulated Cable Engineers Association, Inc.
ICPA	International Cast Polymer Alliance
ICRI	International Concrete Repair Institute, Inc.
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
IES	Illuminating Engineering Society
IPC	Institute of Printed Circuits

IPCEA	Insulated Power Cable Engineers Association
ISA	International Society of Automation
ISO	International Organization for Standardization
LPI	Lightning Protection Institute
MBMA	Metal Building Manufacturers Association
MCA	Metal Construction Association
MHIA	Material Handling Industry of America
MPI	Master Painters Institute
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International (National Association of Corrosion Engineers International)
NAIMA	North American Insulation Manufacturers Association
NBS	National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	NFPA (National Fire Protection Association)
NFPA	National Forest Products Association
NFRC	National Fenestration Rating Council
NHLA	National Hardwood Lumber Association
NLGI	National Lubricating Grease Institute
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	NSF International (National Sanitation Foundation International)
NSPE	National Society of Professional Engineers
NSSGA	National Stone, Sand & Gravel Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PDI	Plumbing & Drainage Institute
SDI	Steel Door Institute
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SPFA	Spray Polyurethane Foam Alliance
SPRI	Single Ply Roofing Industry
SSPC	Society for Protective Coatings
SSPC	Steel Structures Painting Council
SSPWC	Standard Specifications for Public Works Construction
SWPA	Submersible Wastewater Pump Association
UBC	Uniform Building Code (See ICC)
UL	Underwriters Laboratories Inc.
WASTEC	Waste Equipment Technology Association
WCRSI	Western Concrete Reinforcing Steel Institute
WDMA	Window & Door Manufacturers Association
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

COE	Army Corps of Engineers
CPSC	Consumer Product Safety Commission
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
FG	Federal Government Publications
GSA	General Services Administration
HUD	Department of Housing and Urban Development
OSHA	Occupational Safety & Health Administration
SD	Department of State
TRB	Transportation Research Board
USDA	Department of Agriculture
USDJ	Department of Justice
USPS	United States Postal Service

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary of Work" for work restrictions and limitations on utility interruptions.

2. Requirements given in the General Conditions.

1.2 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Engineer, occupants of Project, testing agencies, and authorities having jurisdiction.

1.3 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel. Coordinate location with the Owner.

B. Erosion- and Sedimentation-Control Plan for projects disturbing more than 1 acre: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

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

1.4 QUALITY ASSURANCE

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

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

C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts.

B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide galvanized-steel bases for supporting posts.

C. Wood Enclosure Fence: Plywood, 6 feet high, framed with four 2-by-4-inch rails, with preservative-treated wood posts spaced not more than 8 feet apart.

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Contractor’s Field Office: Of sufficient size to accommodate needs of Owner, Engineer, Construction Manager, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly.

C. Inspector’s Field Office: Provided by the contractor in accordance with General Conditions.

D. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

E. Final location of Contractor’s temporary facilities shall be coordinated with the Owner to ensure that access critical to plant operations is maintained at all times.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures. The Contractor shall provide fire extinguishers and other fire protection equipment to adequately protect new and existing facilities and temporary facilities against damage by fire. Hose connections and hose, water casks, chemical equipment or other sufficient means shall be provided for fighting fires in the new, existing and temporary structures and other portions of the Work and responsible persons shall be designated and instructed in the operation of such fire apparatus so as to prevent or minimize the hazard of fire. The Contractor's fire protection program shall conform to the requirements of the OSHA Standards for Construction. The Contractor shall employ every reasonable means to prevent the hazard of fire.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures".

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary of Work."

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

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

1. The Contractor shall provide an adequate supply of water of a quality suitable for all domestic and construction purposes.

2. Non-Potable water (plant effluent water) may be used for grading and hydraulic structures and pipeline testing as approved by the Engineer. Quantity of utility water available for construction will vary seasonally and daily. The Contractor shall be responsible to obtain information from the Owner and understand the availability of utility water relative to planned construction activities. Currently the plant is treating an average of 3.3 Million Gallons per Day (MGD). The plant is required to discharge 1.8 MGD to Copper's Creek each day. The contractor shall not impede or negatively impact these delivers with construction work and efforts. In addition, non-potable water demands associated with plant operations and maintenance shall take precedence over the Contractor's demands for construction water.

3. The Contractor shall properly identify all construction water trucks and vessels and inform all workmen and the general public when reclaimed waste water is used as construction water.

4. All drinking water on the site during construction shall be furnished by the Contractor and shall be bottled water or water furnished in approved metal dispensers. Notices shall be posted conspicuously throughout the site warning the Contractor's personnel that piped water may be contaminated.

5. The Contractor shall not make connection to, or draw water from, any fire hydrant or pipeline without first obtaining permission of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the water system. For each such connection made the Contractor shall first attach to the fire hydrant or pipeline a valve, backflow preventer and a meter, if required by the said authority, of a size and type acceptable to said authority and agency.

6. Before final acceptance of the Work all temporary water connections and piping installed by the Contractor shall be entirely removed, and all affected improvements shall be restored to their original condition, or better, to the satisfaction of the Engineer and to the agency owning the affected utility.

C. Waste Collection: Provide trash cans and instruct personnel to maintain a clean site.

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

1. Toilets: Portable chemical toilets shall be provided wherever needed for the use of employees. Toilets at construction job sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction. The Owner's toilet facilities shall not be used by the Contractor's work force.

2. The Contractor shall establish adequate and regular collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor or

organic material wastes from any other source related to the Contractor's operations shall be disposed of in a manner satisfactory to the Engineer and in accordance with all laws and regulations pertaining thereto.

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

F. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

G. Electric Power Service: Electric Power Service from Existing System: Electric power from Owner's existing system will be made available for all Field office power requirements and construction activities limited by the plants' electrical system capacity as a whole or at a specific location. All use of power from Owner's existing system shall be coordinated with the Owner and shall be associated with the activities related to construction.

The Contractor shall be responsible to provide necessary electrical power. The contractor will be responsible for all temporary power and generators required during the construction and planned power shut-downs. The Contractor shall provide all necessary temporary power connection, disconnects and distribution lines required for its operations under the Contract and shall provide and maintain all temporary power systems required to perform the Work in a safe and satisfactory manner. All temporary connections for electricity shall be subject to approval of the Engineer and shall be completely removed at the Contractor's expense prior to final acceptance of the Work. All wiring for temporary electric light and power shall be properly installed and maintained and shall be securely fastened in place. All electrical facilities shall conform to the requirements of the OSHA Safety and Health Standards for Construction.

H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

I. Telephone Service: <u>The Owner's telephone system shall not be used by the Contractor's work force.</u>

1. Post a list of important telephone numbers in the project field office.

a. Police and fire departments.
b. Ambulance service.
c. Contractor's home office.
d. Contractor's emergency after-hours telephone number.
e. Engineers' offices.
f. Owner's office.
g. Principal subcontractors' field and home offices.

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

3. The Contractor shall provide a telephone in their facility with an adequate speaker phone for use on conference calls. This system may be used for weekly conference calls/project progress meetings.

J. Electronic Communication Service: Provide a computer in the primary field office adequate for use by Engineer and Owner to access project electronic documents and maintain electronic communications.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
2. Maintain support facilities until Engineer schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, with prior consent from the Owner and under conditions acceptable to Owner.

B. Temporary Roads: Access to the site shall be permitted by the Owner. The Contractor shall not construct any staging areas, haul roads, and access roads without the approval of the Owner.

1. Contractor to maintain clear access roadways and walkways necessary for the daily operation and maintenance of the plant. All road closures, trenching/excavation, or other construction activities that may interfere or impede access must be coordinated with and approved by Owner.

2. A public road passes through the construction area and access to and along this route must be maintained during construction. Contractor shall maintain a graded, non-paved road, to accommodate traffic on the road and allow for construction activities until the permanent road is installed. The general proposed routes for this road are as shown in the general site staging plans provided in the General drawings of Volume 4A. Contractor is responsible to provide suitable road-grade backfill, graded, for the road. Contractor shall maintain and regrade the road as required to maintain the road in acceptable condition. In addition, contractor shall maintain proper barricades and fencing along this road to secure the construction/staging areas from the public access road. Finally, contractor shall furnish traffic controls along public road per Paragraph 3.3.C.

3. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

C. Traffic Controls: Comply with requirements of authorities having jurisdiction and coordinate with the Western Riverside County Regional Wastewater Authority Facility personnel.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

3. Contractor shall provide all lights, signs, barricades, flaggers, and other appurtenances necessary for safety.

D. Parking: Use designated areas of Owner's existing parking areas for construction personnel.

E. Dewatering Facilities and Drains: Comply with all Federal, State, and Local Government requirements. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

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

G. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

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

I. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

J. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

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

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings.

D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

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

G. Site Access: Prior to commencing work the Owner will supply the contractor with access key(s) for the facility front gate. The contractor is responsible to:
   1. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner for any gates, enclosures or fenced areas constructed by the contractor.
   2. The contractor shall be responsible for security of the site during non-working hours of the facility personnel.

H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.

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

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

K. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather tight enclosure for building exterior.

   1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

L. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner and tenants from fumes and noise.

   1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
   2. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.

      a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.

3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
4. Insulate partitions to control noise transmission to occupied areas.
5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
6. Protect air-handling equipment.
7. Provide walk-off mats at each entrance through temporary partition.

M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire prevention program.

1. Prohibit smoking in construction areas.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 MOISTURE AND MOLD CONTROL

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

B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect materials from water damage and keep porous and organic materials from coming into prolonged contact with concrete.

C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Discard or replace water-damaged and wet material.
4. Discard, replace, or clean stored or installed material that begins to grow mold.
5. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
2. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.6 OPERATION, TERMINATION, AND REMOVAL

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

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

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

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

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 015050 – MOBILIZATION

PART 1 - GENERAL

1.1 GENERAL

A. Mobilization shall include the obtaining of all permits; moving onto the project site(s), temporary buildings and other construction facilities; all as required for the proper performance and completion of the Work. Mobilization shall include, but not be limited to, the following principal items:

1. Moving onto the site of all Contractors' project items and equipment required for first month operations.

2. Installing temporary construction power, wiring and lighting facilities.

3. Establishing fire protection equipment and instructing designated personnel in the operation of such apparatus.

4. Providing field office trailer for the Contractor complete with furnishings and utility services. Owner will furnish the water for the Contractor's field offices. Contractor to furnish and install necessary piping, wiring and disconnects.

5. Providing all on-site Contractor communication facilities.

6. Providing on-site Contractor's sanitary facilities.

7. Arranging and setting up the Contractor's work and storage yard.

8. Obtaining all required permits.

9. Posting all OSHA required notices and establishment of safety programs.

10. Have Contractor's superintendent at the jobsite full time.

11. Submittal of Construction Schedule.

12. Install Owner furnished project sign.

1.2 PAYMENT FOR MOBILIZATION

A. The Contractor's attention is directed to the condition that five percent (5%) of the total Contract Price will be deducted from any money due the Contractor as progress payments until all mobilization items listed above have been completed. Any such retention of money for failure to complete all such mobilization items as a lump-sum item shall be in addition to the retention of any payments due to the Contractor as specified in Article 14 of the General Conditions of the Contract.

B. The Contractor shall include a true representation of the value of mobilization in the Schedule of

Values to be submitted as specified under Paragraph 14.01, Supplementary General Conditions. The five percent (5%) of the total Contract Price, mentioned in Paragraph A above, may not necessarily represent the true value of mobilization.

PART 2 – PRODUCTS

Not Applicable

PART 3 – EXECUTION

Not Applicable

END OF SECTION 015050

SECTION 015300 – PROTECTION OF EXISTING FACILITIES

PART 1 - GENERAL

1.1 GENERAL

A. The Contractor shall protect all existing utilities, piping and improvements not designated for removal and shall restore damaged or temporarily relocated utilities, piping and improvements to a condition equal to or better than they were prior to such damage or temporary relocation.

B. The Contractor shall verify the exact locations and depths of all underground piping and utilities shown and not shown and shall make exploratory excavations of all piping and utilities that may interfere with the Work. It shall be the Contractor's responsibility to ascertain the actual location of all existing utilities, piping and other improvements that will be encountered in its construction operations and to see that such utilities or other improvements are adequately protected from damage due to such operations.

C. Maintaining in Service: All pipelines, electrical, power, telephone, communication cables, gas and water mains shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Engineer are made with the Owner. Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing utility or other improvement the Contractor, after necessary scheduling and approval, shall remove and, without unnecessary delay, temporarily replace or relocate such utility or improvement in a manner satisfactory to the Engineer and the owner of the facility. In all cases of such temporary removal or relocation, the Work shall be accomplished by the Contractor in a manner that will restore or replace the utility or improvement to a new condition meeting the specification requirements.

D. All repairs to a damaged utility or improvement are subject to inspection and approval by an authorized representative of the improvement owner before being concealed by backfill or other work.

1.2 RIGHTS-OF-WAY

A. The Contractor shall not do any work or enter upon the rights-of-way of any oil, gas, sewer or water pipeline; any telephone or electric transmission line; any fence; or any other structure, until notified by the Engineer that the Owner has secured authority to do so. After authority has been obtained, the Contractor shall give the governing utility proper advanced notice of its intention to begin work.

1.3 RESTORATION OF PAVEMENT AND SIDEWALKS

A. All paved areas and sidewalks not designated for replacement, cut or damaged during construction shall be replaced with similar materials and of equal thickness to match the existing adjacent undisturbed areas unless otherwise noted. All sidewalks and pavements which are subject to partial removal shall be neatly saw-cut in straight lines.

1.4 UNDERGROUND UTILITIES NOT SHOWN OR INDICATED

A. If the Contractor damages existing utilities, piping or improvements that are not shown or the location of which was not made known to the Contractor prior to excavation and the damage was not due to failure of the Contractor to exercise reasonable care the Contractor shall immediately notify the Engineer. If directed by the Engineer repairs shall be made by the Contractor under the provisions for changes and extra work contained in Articles 13, 14 and 15 of the General Conditions.

1.5 NOTIFICATION BY THE CONTRACTOR:

A. Prior to any excavation in the vicinity of any existing underground facilities, including water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications or telecommunication cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the Contractor shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than three (3) working days prior to excavation so that a representative can be present during such work if they are required to do so.

END OF SECTION 015300

SECTION 015600 – PROJECT ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 EXPLOSIVES AND BLASTING

A. The use or storage of explosives on the work site will not be permitted.

1.2 DUST ABATEMENT AND RUBBISH CONTROL – Refer to Section 017400.

1.3 SANITATION

A. The Contractor shall provide approved fixed or portable chemical toilets wherever needed for its employees. The Contractor shall establish regular intervals of collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of in a manner satisfactory to the Engineer and in accordance with all laws and regulations pertaining thereto. The Owner's toilet facilities shall not be used by the Contractor.

1.4 CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether soil sterilant, herbicide, pesticide, disinfectant, polymer, and reactant, or of other classification, shall show approval for use by either the U. S. Environmental Protection Agency or the U. S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer.

1.5 CULTURAL RESOURCES

A. The Contractor's attention is directed to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical architectural, archeological or cultural resources (hereinafter called "cultural resources"). If potential cultural resources are discovered during subsurface excavations at the site of construction, the following procedures shall be instituted:
   1. The Contractor shall immediately notify the Engineer.
   2. The Engineer will issue a Field Order directing the Contractor to cease all construction operations at the location of such potential cultural resources find.
   3. Such Field Order shall be effective until such time as a qualified archeologist can be called to assess the value of these potential cultural resources and make recommendations to the Applicable State Historical Society Archeologist.

B. If the archeologist determines that the potential find is a bona fide cultural resource, at the direction of the Applicable State Historical Society Archeologist, the Contractor shall suspend work at the location of the find under the provisions for changes contained in Articles 13, 14 and 15 of the General Conditions.

PART 2 - PRODUCTS (Not Used) (Not Applicable)

END OF SECTION 015600

SECTION 016100 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. General Conditions

1.2 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number, manufacturer name, or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.3 ACTION SUBMITTALS

A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable

product request within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.

a. Form of Approval: As specified in Section 013300 "Contractor Submittals."
b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Contractor Submittals." Show compliance with requirements.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

B. To the greatest extent possible for each unit of work, the Contractor shall provide products, materials or equipment from a single source.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

D. Fabricated structural components shall be stored on supports above ground and in a manner to prevent accumulation of water and warping. Products subject to deterioration from atmospheric conditions shall be covered in a manner that will provide adequate ventilation to avoid condensation.

E. Products, materials and equipment not stored in a manner that will insure the maintaining of a new condition will be rejected by the Engineer. Such rejected products, materials and equipment shall be immediately removed from the Work site.

1.6 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. Refer to other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

4. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

B. Product Selection Procedures:

1. Where Specifications name a product or manufacturer as the “Basis-of-Design”, provide product(s) as listed or by the manufacturer listed. Where Specifications include a list of available products or manufacturers, followed by the phrase “or equal,” provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer subject to requirements included in Article 7 of General Conditions.
2. Where specifications and equipment schedules state a make and model number followed by “or approved equal”, special consideration has been given to the design basis equipment with regards to performance, installation footprint, efficiency, compatibility with existing equipment and facilities, or other constraints that require special consideration for any substitute equipment. Accordingly, any proposed substitutes for equipment specified as “or approved equal” must be submitted to Engineer and Owner for review and approval during the bidding process and prior to bid opening. Additional details are available in Volume 1 of the contract documents. Substitutions for equipment and items listed as “or approved equal” that were not submitted and approved before bid opening will be rejected by Owner and Engineer.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016100

SECTION 016600 – EQUIPMENT TESTING AND PLANT START-UP

PART 1 - GENERAL

1.1 GENERAL

A. Equipment testing and plant startup are required for satisfactory completion of the contract and shall be scheduled and completed within the contract time.

1.2 EQUIPMENT TESTING

A. Contractor Furnished Equipment

1. The Contractor shall provide the services of an experienced and authorized representative of the manufacturer of each item of equipment indicated in the equipment schedules who shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The Contractor shall have the manufacturer's representative revisit the Work site as often as necessary until any and all problems are corrected. The Contractor shall require that each manufacturer's representative furnish to the Engineer a written report addressed to the Owner certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchor bolts and has been operated satisfactorily under full-load conditions.

2. The Contractor shall be responsible for scheduling all operations testing. The Contractor shall furnish all personnel, power, water, chemicals, fuel, oil, grease and all other necessary equipment, facilities and services required for conducting the tests. The Contractor is advised that the Engineer and the Owner's operating personnel will witness operations testing and that the manufacturer's representative shall be required to instruct the Owner's operating personnel in correct operation and maintenance procedures. This instruction shall be scheduled with the Engineer and the Owner at least ten (10) days in advance and shall be provided while the equipment is fully operational. The Contractor shall have previously furnished the technical manuals required under Section 013300 entitled, "Submittal Procedures".

B. Owner Furnished Equipment

1. The Contractor shall notify the Engineer when Owner furnished equipment is completely installed in accordance with the Owner furnished equipment manufacturer's instructions and requirements of the Contract Documents and ready for operational testing. The Engineer will schedule the manufacturer's representative to visit the site of the Work and inspect, check, adjust if necessary and approve the equipment installation. If the manufacturer's representative cannot complete the testing and startup services due to the Contractor's negligence in installing the equipment, the Contractor shall be responsible for the costs of the service representatives' revisit to the site of the Work.

1.3 PLANT STARTUP

A. The startup of the treatment plant facilities and equipment is a coordinating operation requiring the combined technical expertise of the Contractor, suppliers, Engineer and the Owner. The Contractor shall provide the effective coordination of all parties necessary for successful plant, facilities and equipment startup.

B. The Contractor shall be required to startup and operate the various pieces of equipment for a continuous seven (7) day period under coordination direction of the Engineer and Owner. The start-up shall not be commenced until all required leakage tests, disinfection and equipment tests have been completed to the satisfaction of the Engineer.

C. All defects in materials or workmanship which appear during this test period shall be immediately corrected by the Contractor. The Contractor shall provide the services of authorized representatives of the manufacturer, in addition to those services required under equipment testing, as may be necessary, to correct faulty equipment operation. Time lost for equipment repairs, wiring corrections, control point settings or other reasons which actually interrupt the startup may, at the discretion of the Engineer, be justifiable cause for extending the startup test duration.

END OF SECTION 016600

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:
1. General Conditions

1.2 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging. The Contractor shall be responsible for the disposal of his own waste. Waste shall daily be cleaned up and piled into proper containers by the Contractor.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

1.3 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 7 days of date established for commencement of the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.

B. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

C. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.5 QUALITY ASSURANCE

A. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.6 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.

PART 2 - EXECUTION

2.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Section 015000 "Temporary Facilities and Controls" and 015600 “Project Environmental Controls” for controlling dust and dirt, environmental protection, and noise control.

2.2 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Burning of waste materials is not permitted.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

2.3 DISPOSAL OF HAZARDOUS WASTE

A. It is not expected that hazardous materials will be encountered in the Work. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner’s representative.

END OF SECTION 017419

SECTION 017500 – COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This specification discusses pre-commissioning and commissioning activities. Pre-commissioning activities include all the activities associated with the first-time startup of all equipment, instruments, electrical gear and/or process. This includes all checks and tests prior to running equipment including any manufactures inspections. Commissioning activities include but are not limited to the Functional Acceptance Test (FAT) of equipment and facilities with clean water, operator training and manufactures start up services. The final step in commissioning includes a Reliability Acceptance Test (RAT). This test will require the system to function for an extended period without interruption as listed in Table 2. After the test period is complete, the system will be substantially complete and can be turned over to the Owner for beneficial use.

B. For the purpose of this Project, commissioning will start after Owner's acceptance of Operational Readiness Test (ORT) and the listed requirements in Table 1. Full operational tests that demonstrate functionality and reliability will be done during commissioning. It may be necessary to include the installation of temporary facilities to support testing and the removal of temporary facilities when testing is complete. It is the Contractor's responsibility to execute proper planning, notification and scheduling. The commissioning activities will involve the Owner, Engineer, Construction Manager, Contractor and staff responsible for plant operation. The Contractor will provide a Commissioning Coordinator to lead all commissioning activities.

C. This section identifies the tests and documentation that the Contractor shall be responsible for in order to complete pre-commissioning and commissioning. All pre-commissioning and commissioning work, as described in this section, shall be performed by the Contractor and witnessed by the Owner.

D. Related Requirements:

1. Section 011000 – Summary of Work
2. Section 016600 – Equipment Testing and Plant Startup
3. Section 017823 – Operation and Maintenance Data
4. Section 017839 – Project Record Documents
5. Section 260000 – General Electrical Requirements
6. Section 407000 – Instrumentation for Process Systems

1.2 DEFINITIONS

A. Operational Readiness Test (ORT): This test includes all parts of a system to verify they are in working order and functioning properly in the system including, but not limited to verification of proper alignment, pressure tests, rotational checks, control devices, loop checks and other items listed in Table 1. The requirements of the ORT are described in detail in Section 1.3 Pre-commissioning Work.

B. Functional Acceptance Test (FAT): The FAT is used to test the system prior to placing it into service. The test is to prove the system is operational using clean water insuring normal operating requirements. The requirements for the FAT are listed in Section 1.4 Commissioning Work.

C. Reliability Acceptance Test (RAT): The RAT is used to prove the reliability of the system for a duration listed in Table 2. The test is performed under normal plant flows using typical process influent with the assistance of plant operators. The requirements for the RAT are listed in Section 1.4 Commissioning Work. Following successful completion of the RAT, and acceptance of the system by the Owner, the Contractor may apply for substantial completion of the system.

D. Substantial Completion: That date as certified by the Engineer when the construction of the Project or a specified part thereof is sufficiently completed, in accordance with the Contract Documents so that the Project or specified part can be utilized for the purposes for which it is intended. The Contractor may apply for Substantial Completion after the Engineer has accepted all Reliability Acceptance Tests (RATs) in accordance with technical specifications section 017500 - Commissioning and the Contractor has submitted all Manufacturers' Certificates of Proper Installation and all Operation and Maintenance Manuals have been submitted and have been approved by the Engineer.

E. Final Completion: Includes all Work under the Contract as outlined in the contract documents, including any approved change orders.

F. System: A system means the overall process, or a portion thereof, that performs a specific function.

G. Commissioning Coordinator: The Commissioning Coordinator is employed by the Contractor and responsible for all commissioning activities, scheduling start-up and training sessions, developing and submitting all reports and certificates. The Commissioning Coordinator shall have no other responsibilities during commissioning and will be on site during all commissioning phases. The Commissioning Coordinator shall be a registered engineer in the State of New Mexico or a currently licensed grade 5 wastewater treatment operator in the state of New Mexico.

H. Owner: Owner is defined as South Davis Sewer District. The term Owner also includes the Owners representatives, which includes the Construction Manager, Engineer and Plant Operations Staff.

I. Plant Water: Plant Water is fully treated plant effluent and is considered non-potable water.

1.3 PRE-COMMISSIONING WORK

A. Pre-commissioning is made up of all the activities that shall be completed before the Contractor is permitted to begin Commissioning. Table 1 illustrates some of the tasks.

B. The primary activities for this are construction, factory testing, documentation, component testing, stand-alone equipment testing, and energization of electrical power distribution equipment. This also includes pipe pressure testing. The intent is to test isolated equipment and components. Pre-commissioning testing shall conclude with the Owner's acceptance of the Operational Readiness Tests.

C. Once all components have been tested individually, electrical power distribution equipment has been functionally tested and energized, and Owner has accepted all required deliverables, the Contractor may request to proceed to Commissioning. If the Owner agrees that the Contractor has successfully performed all tests and provided all required documentation, the Owner will notify the Contractor in writing that he may begin Commissioning.

1.4 COMMISSIONING WORK

A. Commissioning is composed of two parts, Phase 1 and Phase 2 (note that terms Phase 1 and Phase 2 are not associated with construction phasing and are solely used to describe commissioning requirements). Table 1 illustrates some of the tasks.

1. Phase 1 Commissioning will include operator training as well as comprehensive testing with clean water. The steps will include approval of Operational Readiness Tests and the Functional Acceptance Test (FAT). The purpose of the FAT is to test all equipment, instruments and software as an integrated system using plant water wherever applicable. The successful completion of the Functional Acceptance Test will allow the Contractor to request Operational Acceptance. When all deliverables have been accepted and operator and maintenance training is complete, Owner will notify the Contractor in writing that the facility has achieved Operational Acceptance and he may proceed to the next phase of Commissioning.
2. Phase 2 Commissioning is designed to functionally test the facility as an integrated system under normal operating conditions using wastewater. The testing includes the Reliability Acceptance Test (RAT) that will be conducted over a period of time that demonstrates the operational reliability of the system. (See Table 2 for test durations.) After successful completion of the RAT and all Manufacturers' Certificates of Proper Operation have been submitted to Engineer, and after the Contractor has submitted all Operation and Maintenance Manuals, the Contractor may request the Owners' acceptance that the system is Substantially Complete.

1.5 MANUFACTURER'S FIELD SERVICES

A. It is the Contractor's responsibility to provide the services of the manufacturer's representatives that apply during equipment installation, facilities testing, pre-commissioning, commissioning and training of the Owner's personnel. Where manufacturer's services are specified, the Contractor shall furnish a qualified representative of the manufacturer to provide these services.

B. Definitions: For purposes of furnishing manufacturers' services, the following definitions shall apply:

1. Manufacturer's Representatives: Employee of manufacturer who is factory trained and knowledgeable in technical and operational aspects of their products and systems.
2. Person-Day or Instructor-Day: One person for eight (8) hours straight time, exclusive of Saturdays, Sundays or holidays; does not include travel time.

C. Submittals

1. Submittals shall be in accordance to General Requirements Section 013300 entitled "Contractor Submittals" and the requirements of this section.

2. Qualifications and experience records of proposed manufacturers' representatives who will assist installation and testing of equipment and conduct training sessions.
3. After installation, each manufacturer's representative shall submit to the Owner, via the Construction Manager, a written report (Certificate of Proper Installation) certifying that all equipment is installed properly, in accordance with the manufacturer's installation instructions.
4. During Phase 2 of Commissioning and after the RAT, each manufacturer's representative shall submit to the Owner a written report (Certificate of Proper Operation) certifying that all equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated per specifications.

D. Scheduling of Manufacturer's Field Services

1. The manufacturer's representative shall be an experienced, competent, and an authorized representative of the manufacturer of each item of equipment for which field services are indicated in the individual sections of the Contract Specifications. He shall visit the site of the Work to inspect, check, adjust if necessary, and accept the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is being tested and placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected.
2. The scheduling of all visits to the site by the manufacturer's field services representative shall be determined by the Contractor and accepted by Owner. It is intended that the manufacturers' representatives' visits be for making equipment inspections and normal adjustments, and not for remedying defective work.
3. Manufacturers' representatives shall resolve assembly or installation problems attributable to or associated with, their products and equipment.
4. During the testing, the manufacturer's representative shall assist, as applicable, to perform initial equipment and system adjustments and calibrations.
5. After all acceptance tests have been completed, but prior to Substantial Completion, the Contractor shall recheck all equipment for proper alignment and adjustment, check oil levels, re-lubricate all bearing and wearing points, and, in general, assures that all equipment is in proper condition for regular continuous operation.

PART 2 - PRODUCTS

2.1 COMMISSIONING PLAN

A. The Commissioning Coordinator shall be responsible for preparing the Commissioning Plan.

B. As a condition precedent to receiving any progress payment for work 30 days prior to the pre-commissioning activities, the Commissioning Coordinator shall submit and receive the Owner's acceptance for all commissioning plan documents. The Owner shall require five (5) copies to review the submitted commissioning plan. The commissioning plan shall be submitted 60 days preceding commissioning of a system.

C. Once the Owner has accepted the Commissioning Plan, the Commissioning Coordinator shall reproduce the plans in sufficient number for the Commissioning Coordinator's purposes and an additional five (5) copies for delivery to the Owner. No test work shall begin until the

Commissioning Coordinator has delivered the specified number of final commissioning plans to the Owner.

D. Testing

1. The Contractor shall develop and produce the ORTs, FATs and RATs to conduct the testing. Sample templates for ORT, FAT and RAT have been provided in Exhibit 1 – Commissioning Document Samples of this specification to help facilitate this production.
2. The Contractor shall submit an EPSET procedure, as defined in Section 2.2.B.1 entitled EPSET - Electrical Power System Energization Test.
3. The Commissioning Coordinator shall develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this Contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or tag number each device or control station to be manipulated or observed during the test procedure. The specific results to be observed or obtained shall be identified in the plan. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, Subcontractors' and manufacturers' representatives to be present and expected test duration.
4. The Commissioning Coordinator shall prepare written test procedures for submittal to the owner and Engineer, for acceptance. The test procedures shall be submitted in hard copy and electronically as needed. For each test, the procedure form should clearly define the following:
    a. Test Number
    b. Purpose of the test: Describe what is being verified by this particular test.
    c. Test Method: Describe the setup for the test and the steps required to complete the test.
    d. Criteria: Describe the criteria for passing or failing the test.
    e. Provide space on the form for the Owner’s comments and for individual sign-off.
    f. Test on a loop-by-loop basis. Every loop shall be signed off individually.
    g. Provide a test schedule.
    h. Provide a list of all test equipment to be available for the tests.
    i. Provide a block diagram showing the test setup arrangement. The diagram shall illustrate the equipment under test, any special test equipment and indicate equipment interconnections.
5. Staffing for each test identifying roles and responsibilities.
6. For all ORT testing, the Contractor shall use the final project PLC hardware.
7. Instrumentation list with calibration methods and calibration dates.
8. Acceptance criteria required to release equipment and systems for commissioning.
9. Statement of successful test.
10. Forms for each test.

E. Training

1. Identify each operator and maintenance training class.
2. Lesson plan for each class.

F. Schedule: The Commissioning Coordinator shall produce a test and training schedule setting forth the sequence contemplated for performing the test and training work.

1. The schedule shall detail the equipment and systems to be tested, and shall be part of the Contractor's Baseline Construction Schedule.
2. The schedule shall show the contemplated start date, duration of the test and completion of each pre-commissioning and commissioning activity.
3. The test schedule shall be submitted, reviewed, and accepted by the Owner with the Baseline Construction Schedule.
4. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of the Contract Documents.
5. Daily Schedule for Testing
    a. The Commissioning Coordinator shall begin each day of witnessed testing by meeting with the Owner.
    b. The meeting purpose is to review the test schedule, the test results from the previous day, and where applicable, to coordinate the testing schedule with Plant Operations.
    c. Note that the Commissioning Coordinator will need to schedule some testing outside normal working hours because of plant operational requirements. The Commissioning Coordinator may be required to rearrange portions of the testing schedule at short notice to accommodate unanticipated plant conditions such as equipment failure or unusually high sewage flows caused by wet weather.
6. Show all tests with beginning and ending dates. At a minimum, the Commissioning Coordinator will show all ORT, FAT and RAT schedules.
7. Show all operations and maintenance training classes.

2.2 PRE-COMMISSIONING AND COMMISSIONING TESTS

A. The following tests are conducted by the Commissioning Coordinator during Pre-commissioning and Commissioning.

B. Pre-commissioning: The Contractor shall successfully complete each test and receive written confirmation prior to starting any Commissioning Tests.

1. EPSET - Electrical Power System Energization Test – This test is performed after installation of all electrical switchgear systems and MCCs, after completion of NETA testing of the electrical power distribution system and after receipt of vendor certificate of proper installation. An accepted EPSET procedure shall be used to perform this test. The purpose of EPSET is to ensure 480V and greater power distribution is functional and ready for energization during commissioning. Prior to energization, PLC I/O check will not be possible; it will be part of ORTs and FAT testing. The Contractor cannot power any equipment i.e. lighting panel, PLC panels, etc. until EPSET is complete. Arc Flash labels shall be placed on electrical equipment prior to start of EPSET.
    a. This test will check and document that all local manual, remote and automatic interlocks, switching scenarios, I/O and controls are functional; any temporary power for testing of breakers, switchgear and battery charger system (125 V dc), if required, shall be provided. The Owner's personnel will witness this test. Qualified Contractor and vendor personnel capable of operating and troubleshooting electrical equipment shall be available during the course of this test. The Contractors' Commissioning Coordinator shall direct test.
    b. The Contractor shall submit an EPSET procedure. The EPSET procedure shall include the following:

1) Steps to test and check all modes of operation (local, remote, manual, automatic and PLC), verify all required switching scenarios and functions, and verify that precluded switching scenarios do not occur,
2) Methodology for supplying temporary power (if required)
3) Steps to coordinate administrative control of project electrical equipment that interfaces with existing electrical equipment to ensure that testing does not negatively affect Plant operations.

c. Prior to commencement of the EPSET, the following documentation shall be submitted and made available to the Owner:
1) An accepted EPSET procedure
2) All associated redlined as-built single line and loop drawings
3) Electrical equipment O&M manuals and schematics
4) Certificate of Proper Installation
5) NETA testing reports and required testing outlined in Division 26 – Electrical

d. Prior to commencement of the EPSET, vendor training of personnel for electrical equipment shall be competed.

2. ORT - Operational Readiness Test - This test is performed after installation and calibration of instruments is complete. The test purpose is for the Contractor to check and document the complete control system, including I/O to/from PLC register but excluding the application software is ready for operation. In addition, the equipment shall be tested in local/manual mode for operation and functionality. This test will be required for all electrical, piping and mechanical equipment, including but not limited to, actuated valves and gates, meters, conveyors, blowers, compressors, mixers, screens, motors, boilers, bio-gas handling equipment, pumps and filters. Upon completion of the test, the Contractor shall leave the equipment de-energized.

a. After the equipment supplier has certified proper installation, Contractor shall submit printouts for VFD, RVSS, relays and similar parameter settings for review by the Owner prior to starting the ORT. If further tuning is required when equipment is under load, as during FAT or RAT, the Contractor shall arrange to have on site the Supplier to finalize settings. When complete, the Contractor shall provide printouts of parameter settings and submit to the Owner. The final parameter settings shall be included in the Final Vendor Equipment Manual submittal. The Owner shall witness all ORT's. After the ORT's for a system is complete and approved by the Owner the commissioning can begin.

C. Commissioning

1. Phase 1. FAT – Functional Acceptance Test – The FAT is a combined effort between the Contractor and Owner. The combined software/hardware system is tested from this point forward. This test shall be conducted for LOCAL control; REMOTE MANUAL control; REMOTE AUTO control; REMOTE CASCADE (if applicable) control. The purpose for the test is to insure that the PLC and Operator Graphics software configuration is working in conjunction with the hardware and plant as intended. This test is accomplished with the system online under normal operating conditions. Equipment will operate with plant water. After acceptance of the FAT by the Owner, the Contractor may request to start with Phase 2.
2. Phase 2. RAT – Reliability Acceptance Test – The Purpose for this test is for the Contractor to demonstrate that all systems are capable of operating continuously in the intended manner for an extended period without failing. During the RAT, the Contractor will be responsible for recording all readings, collecting all samples and conducting laboratory analysis. During the RAT, the system under test will be operated within design parameters

reflecting the day-to-day operation of the facilities for an uninterrupted period. The duration for each system is listed in Table 2. Several systems may have to test simultaneously in order to treat the wastewater adequately. Each system will require its own RAT, but all of the above systems must start up together. The existing systems must remain operational during the test in case of a problem during the test period.

3. Unless noted otherwise in Table 2 of this section, the RAT will run for 7 continuous days without interruption. During the test, operation of the system will be under the direction of the Contractors Commissioning Coordinator with assistance from Equipment Manufacturers, Sub-Contractors, Owner and Plant Operators. The test, to the greatest extent possible, will take place at 80% of design flow for each process or piece of equipment. The test may need to be terminated due to above average rainfall, unforeseen conditions at the plant or any malfunction with the equipment causing the plant not to meet its discharge requirements. The Plant must be able to return to normal operation prior to the test if suspension of the test in necessary.
4. If the system test is suspended for a period over, 4 hours due to equipment malfunction or break down, the, the entire test will be void and will need to start at the beginning of the test period.

2.3 PRE-COMMISSIONING AND COMMISSIONING DOCUMENTATION

A. Pre-commissioning: The following documentation shall be up to date and accepted by the Owner prior to starting any Commissioning activities. The Owner will give written notice to the Contractor when all the documents are accepted.

1. Equipment Submittal Process Complete.
2. RFIs and Responses up to Date.
3. All Electrical Equipment Tests.
4. All Process and Instrumentation Equipment Tests.
5. All Mechanical Equipment Tests.
6. Loop Drawings.
7. P&ID Drawings.
8. Contractor Lock-out Tag-out Procedures.
9. All Vendor and Manufacturer Certificates of Correct Installation.
10. All Pressure Test Reports.
11. All Loop Test Reports.
12. All Conductivity Test Reports.
13. All Instrument Calibration Reports, including parameter settings for magnetic flow meters, ultrasonic level elements, transmitters and similar instruments requiring calibration.
14. All Electrical Breaker Setting Reports.
15. All Mechanical Alignment Reports.
16. Draft Operations and Maintenance Manual.
17. Any and All Operating Permits.
18. Operator Training Plan.
19. Pre-commissioning Report.

B. Commissioning: The following documents shall be submitted by the Commissioning Coordinator to Owner during commissioning:

1. Redline As-Built Drawings.
2. Final Maintenance Manuals.

3. Final Punch List.
4. Commissioning – Phase 1 Report.
5. Commissioning – Phase 2 Report.

2.4 DOCUMENTATION

A. The Commissioning Coordinator shall develop a records keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.

B. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test, and signature spaces for Owner's witness and the Contractor. A separate file shall be established for each system and item of equipment. For process systems that require commissioning prior to taking another process system out of service, the documentation shall be provided for each process system to be completed independently. These files shall include the following information as a minimum:

1. Metallurgical tests (If applicable).
2. Factory performance tests.
3. Accelerometer recordings made during shipment.
4. Field calibration tests.
5. Field pressure tests.
6. Field performance tests.
7. Field operational tests.

C. The Commissioning Coordinator shall develop test documentation forms specific to each item of equipment and system installed under this Contract.

D. Once the Owner has reviewed and taken no exception to the forms proposed by the Commissioning Coordinator, the Commissioning Coordinator shall produce sufficient forms, at his expense, to provide documentation of all testing work to be conducted as a part of this Contract.

E. Reference Documentation

1. The Commissioning Coordinator shall make two sets and a digital file of the following documentation available to the Owner or its representatives, at the test site:
   a. All drawings, specifications, addenda and change-orders;
   b. Copy of the accepted test procedure for the specific equipment being tested and record keeping forms filled out during testing.

2.5 REPORTS

A. The Contractor shall submit several reports to the Owner for acceptance in order to continue with the Commissioning process. For process systems that require commissioning prior to taking another process system out of service the reports shall be submitted for each process system as completed. These shall be submitted in hard copy and electronic format. The reports are described

below. One each of these tests is required even though not specifically listed in the detailed specification section.

B. Pre-commissioning Report: The Pre-commissioning Report is a collection of all test reports, test data, certificates and commissioning forms that are produced during the Pre-commissioning Stage. The first section of this document will be a summary of the contents certifying that all prescribed tests and procedures have been successfully completed. The Commissioning Coordinator is responsible for producing this document.

C. Commissioning – Phase 1 Report

1. The Phase 1 Report is a collection of all test reports, test data, certificates and commissioning forms that are produced during the Phase 1 Stage. The first section of this document will be a summary of the contents certifying that all prescribed tests and procedures have been successfully completed. The Commissioning Coordinator is responsible for producing this document.

D. Commissioning – Phase 2 Report

1. The Phase 2 Report is a collection of all test reports, test data, certificates and commissioning forms that are produced during the Phase 2 Stage. The first section of this document will be a summary of the contents certifying that all prescribed tests and procedures have been successfully completed. The Commissioning Coordinator is responsible for producing this document.
   a. Manufacturer's equipment data.
   b. Field recorded dimensional measurements and clearances.
   c. Pressure, pressure differential, level, flow and other field settings.
   d. All electrical devices field settings.
   e. Operational pressure tests, control system timing tests and settings and other test data specified.
   f. Field wiring changes made, including marked up drawings.

2.6 SUBMITTALS

A. Contractor shall submit the following information in addition to specific equipment where specified in individual sections and paragraphs:

1. Manufacturer’s Certification of Proper Installation of all equipment.
2. Completed ORT, FAT and RAT forms.

B. Submit design and details of temporary test equipment and facilities.

C. Formal Reports

1. Submit two (2) bound copies and one (1) digital file of all start-up and test reports within thirty days after completion of last test.

PART 3 - EXECUTION

3.1 PRE-COMMISSIONING AND COMMISSIONING ACTIVITIES

A. The following is a partial list of activities that shall be complete during each stage of Commissioning.

B. Pre-commissioning

1. Electrical Service Tie-ins.
2. Electrical Testing.
3. Electrical Equipment is Clean and Energized.
4. Mechanical Equipment is Clean and Energized.
5. Verify Rotation of Motors.
6. Verify Alignment of Equipment.
7. Perform Local Manual Mode Tests.
8. Piping Equipment is Complete and Pressure Tested.
9. Pipe Supports Complete.
10. Pipe is Clean of Debris (inside and out).
11. Verify Valve Operation and Positions for Commissioning.
12. SCADA System is Complete and Energized.
13. Perform Wiring and Loop Tests.
14. PLC Programming Complete.
15. Perform Electrical Power System Energization Test (EPSET).
16. Perform Operational Readiness Test.
17. Pre-commissioning Requirements.

C. Commissioning

1. Operator Training.
2. Prepare As-Built Drawings.
3. Functional Acceptance Test (FAT).
4. Reliability Acceptance Test (RAT).
5. Prepare Final Maintenance Manuals.
6. Complete Final Punch List.

TABLE 1
PRE-COMMISSIONING AND COMMISSIONING

<table>
<tr><th rowspan="2">PRE-COMMISSIONING</th><th colspan="2">COMMISSIONING</th></tr>
<tr><th>PHASE 1</th><th>PHASE 2</th></tr>
<tr><td>Equipment Submittal Process Complete</td><td rowspan="2">Redline As-Built Drawings Received Prior to Operator Training</td><td rowspan="2">Reliability Acceptance Test (RAT)</td></tr>
<tr><td>RFI's and Responses up to Date</td></tr>
<tr><td>All Electrical Equipment Tests Complete</td><td rowspan="2">Operational Readiness Tests Reports Approved</td><td rowspan="2">All Manufactures Certificates of Proper Installation and Training</td></tr>
<tr><td>All Process and Instrumentation Tests Complete</td></tr>
<tr><td>All Mechanical Equipment Tests Complete</td><td rowspan="2">Operator Training Completed Prior to Phase 2</td><td>Commissioning - Phase 2 Report</td></tr>
<tr><td>Loop Drawings</td><td rowspan="2">Substantial Completion of System</td></tr>
<tr><td>P&ID Drawings</td><td>Functional Acceptance Test (FAT)</td></tr>
<tr><td>Contractor Safety Procedures in place</td><td>Commissioning - Phase 1 Report</td><td>Final O&M Manuals</td></tr>
<tr><td>Equipment, Valve and Pipe Labeling Complete</td><td rowspan="3">Obtain operational acceptance from the Owner to Proceed to Phase 2</td><td>Final Punch List Complete</td></tr>
<tr><td>All Manufactures Certificates of Proper Installation</td><td>Final As-Built Drawings</td></tr>
<tr><td>All Pressure Test Reports</td><td>Final Completion</td></tr>
<tr><td>All Loop Test Reports</td><td colspan="2" rowspan="16"></td></tr>
<tr><td>All Conductivity and Megger Test Reports</td></tr>
<tr><td>All Instrument Calibration Reports</td></tr>
<tr><td>All Breaker Setting Reports</td></tr>
<tr><td>All Mechanical Alignment Reports</td></tr>
<tr><td>Operator and Maintenance Training Plan</td></tr>
<tr><td>Commissioning Plan Accepted</td></tr>
<tr><td>Draft O&M Manuals Submitted and Approved</td></tr>
<tr><td>Electrical Power System Energization Test</td></tr>
<tr><td>Operational Readiness Tests (ORT's) Complete</td></tr>
<tr><td>Pre-commissioning Report Submitted</td></tr>
<tr><td>Obtain Owner Approval to Proceed to Commissioning Phase 1</td></tr>
</table>

TABLE 2
RELIABILITY ACCEPTANCE TEST PARAMETERS

SYSTEM	TEST DURATION
Tertiary Filters	7 Continuous Days without a problem

EXHIBIT 1

COMMISSIONING DOCUMENT SAMPLES

OPERATIONAL READINESS TEST (ORT)

FUNCTIONAL ACCEPTANCE TEST PROCEEDURE (FAT)

SAMPLE RELIABILITY ACCEPTANCE TEST PROCEEDURE (RAT)

OPERATIONAL READINESS TEST
SOUTH DAVIS SEWER DISTRICT
NORTH PLANT UPGRADE

Date:_____
Equipment Name:_____ Equipment #:_____
Test Type:_____ System:_____

Step	ok Contractor	ok Sub	Signature or comments for non-acceptance(Owners Rep) Comment / Sign Off
Verify ready for startup by manufacture if applicable			
Verify correct installation			
Verify correct electrical and control wiring (voltage, breaker settings, etc.)			
Verify all lubrication is complete and correct			
Check rotation (uncouple motor from equipment if required)			
Verify all alarms and signals are functioning (simulate signal if needed)			
Verify all H/O/A switches function			
Verify all emergency stops function			
Check clearances and verify all guards are in place			
Verify loop checks are complete and test operation through the PLC			
Equipment is ready for system Functional Acceptance Test (FAT)			

FUNCTIONAL ACCEPTANCE TEST PROCEDURE (FAT)

1.1 OVERVIEW

A. The purpose of the Functional Acceptance Test (FAT) is to demonstrate to the Owner that both the software and hardware installed under this Contract is performing as specified. The test is performed with the equipment in service using plant water. The FAT is a combined effort between Contractor and Owner. The tests will require coordination with Operations to ensure normal processing is not disrupted. A Plant Operator must be present when any system operated may disrupt normal plant operation. Each individual piece of equipment shall have a completed ORT prior to the system FAT. This schedule will be based on work sequencing as discussed in the Contract Documents.

1.2 TEST PROTOCOL

A. The combined software/hardware system is tested from this point forward. The test is performed with equipment in service under normal operating conditions, and extreme design conditions (max and min), to the extent that test conditions allow. The purpose of the test is to ensure that the PLC and Operator Graphics software configuration is working in conjunction with the hardware and plant as intended.

B. Equipment will operate with plant water. Application software problems encountered during the test will be investigated and corrected by the Contractor. Problems with PLC and/or SCADA software programming done by the Owner will be corrected by the Owner. The Contractor shall provide a qualified person familiar with the installation and trouble-shooting of PLC panels, working full time, under the direction of the Commissioning Coordinator, for the duration of the test. Prior to the test, the Contractor shall submit a written FAT procedure, prepared by the Commissioning Coordinator, to the Owner for approval. The Owner's approval of the procedure prior to the start of the FAT is required.

C. Alarms and interlocks are simulated in the field by activating the final element (sensor) or where this is not possible, by simulating the test condition at field terminals as close as possible to the final element. Calibration checks completed for the Operational Readiness Test will not be repeated.

D. The Owner must be notified 48 hours prior to the start of the FAT and must be present during the test.

E. Any sections of the test are found to be unsatisfactory; the Contractor will be required to repeat the test at his expense.

1.3 COMPONENTS

A. Each component of a system shall be brought on line as required to simulate a fully functioning system.

B. Each component shall be tested at normal plant flows. If it is not possible to produce the flow, it can be simulated for this testing purpose.

C. Each component shall be fully functional and compatible with the system at the conclusion of the FAT.

D. Any repair or replacement of system components shall be completed and tested prior to final approval and beginning the RAT (Reliability acceptance Test).

1.4 TEST PROCEDURE

A. The Commissioning Coordinator shall prepare a written procedure and sign off sheet for each system. The sheet shall include all necessary components and requirements for the system. The procedure must be submitted to the Owner twenty-one (21) working days prior to the test for approval and comments. The Owner must approve the procedure prior to proceeding with the test.

B. Following is a general procedure for conducting the FAT:

1. Schedule test time with the Owner.
2. Set all valves and gates to the required position.
3. Fill channels and basins with Plant Water to prepare for the startup.
4. Energize electrical equipment.
5. Check and calibrate all transmitters, sensors, alarms and meters.
6. Simulate high, normal and low flow conditions.
7. Verify operation and reporting of the system through the SCADA System as well by manual operation.
8. Obtain approval from the Owner prior to terminating the test.

SAMPLE FUNCTIONAL ACCEPTANCE TEST PROCEDURE EXAMPLE PUMP STATION #1			
#	**Test and Setup**	**Required Results**	**Sign-off / Comments**
1	Verify all ORT's are complete and accepted by Owner	All ORT's complete (Provide copies of all ORT's)	
2	Notify Owner	All required people notified to observe test	
3	Verify all local and remote switches are in the off position	No unwanted starting of equipment	
4	Energize equipment at the MCC and power panel		
Example Pumps #1 through #3			
1	Open isolation valves	Pumps should not operate unless the isolation valves are open.	
2	Verify proper operation of level instruments	Verify the level instruments operate as intended.	
4	Verify downstream processes are ready to receive flow.	Pumps should not be operated unless downstream processes are available to receive flow.	
5	Provide utility water to wet well and fill wet well as needed.	Pumps should not operate without water in the wet well.	
6	Turn HOA switch to Hand	Verify the pump operates and run at appropriate flow/head conditions.	
7	Turn HOA switch to Auto	Pump should not operate until water level is at high level setpoint.	
8	Verify pump alarms along with pump on and pump off sequence with HOA in Auto.	Pump should operate as intended in Auto.	
9	De-energize equipment until Reliability Acceptance Test (RAT)	Contractor lock out tag out procedure	

Test Completion Endorsements			
		Signature/Date (Contractor)	Signature/Date(Owners Rep)
1	All components are complete and functioning.		
2	Acceptance to move on to Reliability Acceptance Test (RAT)		

SAMPLE RELIABILITY ACCEPTANCE TEST PROCEDURE (RAT)
EXAMPLE PUMP STATION #1

1.1 OVERVIEW

A. The RAT for the Example Pump Station #1 will involve other areas or systems that must start simultaneously; they are listed in Sequence of Operations in Section 011000, "Summary of Work". Each related area will have its own RAT. The Commissioning Coordinator will be responsible to prepare each RAT and schedule the startup of the systems with the Owner. The RAT cannot begin until the Functional Acceptance Tests (FAT) is complete and passed off by the Owner for all of the related areas.

1.2 CONSTRAINTS

A. The RAT will run for 7 continuous days without interruption or problem (unless a different duration is noted in Table 2 above). During the test, the responsibility for operation of the system and direction for testing falls on the Contractors Commissioning Coordinator with assistance from Equipment Manufacturers, Sub-Contractors, Engineer, Owner and Plant Operators. The test, to the greatest extent possible, will take place at 80% of design flow for each process or piece of equipment. The test may need to be terminated due to above average rainfall, unforeseen conditions at the plant or any malfunction with the equipment causing the plant not to meet its discharge requirements. A contingency plan in case the RAT is suspended must be submitted.

B. If the system test is suspended for a period over 4 hours, due to equipment malfunction or break down, the entire test will be void and will need to start at the beginning of the test period.

C. The RAT must be repeated and run for an additional 7 continuous days without interruption and or problem following the construction and FAT for the Equalization Basin.

1.3 PROCEDURE

A. Prior to beginning the Influent Pump Station RAT, all of the related systems must be ready for their own RAT. These are identified in the Sequence of Operations in Section 011000, "Summary of Work." The contractor, with the approval of the Owner, may modify this list of related areas.

B. All ORT's and the FAT must be complete and approved prior to beginning the RAT. Documentation requirements will be discussed with the Commissioning Coordinator and Owner. The Commissioning Coordinator will create the logs, and record the information. The logs will be submitted to the Owner for acceptance at the conclusion of the test and have the logs available for review during the test.

C. A written procedure will be submitted to the Owner 60 days prior to the test for approval and comment. A sample startup activity list for the Influent Pump Station is provided below.

EXAMPLE WET WELL #1 STARTUP ACTIVITY		
1.	Verify completion of ORT's and FAT.	
2.	Verify the Owner has approved the RAT procedure.	
3.	Verify all downstream systems are ready to accept flow. (See Section 011000 for a list of related systems.)	
4.	Startup meeting with Owner, Plant Operators, Commissioning Coordinator and Engineer reviewing the startup plan.	
Pump Station #1		
	Downstream Process Equipment should be operating	
1.	Open the appropriate pump isolation valves.	
2.	Energize Pumps #1, #2 and #3	
4.	Set the HOA switch for Pumps #1, #2 and #3 to Auto.	
5.	Open the appropriate isolation valves and/or gates to introduce flow to the wet well.	
6.	Verify the operation of the pump station.	
8.	Start the clock for the RAT.	

DOCUMENTATION

A test and issue log will be the only required documentation for the Influent Pump Station RAT. A sample log sheet is provided below.

EXAMPLE PUMP STATION #1 TEST AND ISSUE LOG										
Activity/Equipment	Start Time/Date	Verify Proper Operation Initial Y=Yes N=No							Stop Time/Date	Comments/Issues (Use additional sheet if needed.)
		S	M	T	W	T	F	S		
Pump #1										
Pump #2										
Pump #3										
Level Sensor #1										
Level Alarm Low										
Level Alarm High										
Level Alarm High/High										
Note:										
Contractor Approval:										
Engineer Approval:										
Owner Approval:										

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Section 017500 “Starting and Adjusting” for commissioning requirements.
2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.2 ACTION SUBMITTALS

A. Product Data: For cleaning agents (submitted by the Contractor)

B. Contractor's List of Incomplete Items: Initial submittal by the Contractor at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal by the Contractor at Final Completion.

1.3 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.4 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order.

2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include comments from the Construction Manager, Owner and Engineer.
4. Submit list of incomplete items in the following format:

    a. MS Excel electronic file. Engineer will return annotated copy.
    b. PDF electronic file. Engineer will return annotated copy.
    c. Three paper copies unless otherwise indicated. Engineer will return two copies.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 14 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number where applicable.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer’s signature for receipt of submittals.

5. Submit test/adjust/balance records.
6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 14 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video as required.
6. Advise Owner of changeover in heat and other utilities.
7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.

8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements, including touchup painting.
10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 14 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer and Construction Manager will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

1.5 FINAL COMPLETION PROCEDURES

A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
1. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
2. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection to determine acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.6 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

C. Provide additional copies of each warranty to include in operation and maintenance manuals.

D. Operating manuals, technical manuals and instructions. The Contractor's attention is directed to the condition that one percent (1%) of the contract price will be deducted from any monies due the Contractor as progress payments if at the seventy-five percent (75%) construction completion point the approved technical manuals have not been submitted in accordance with Section 013300 entitled, "Contractor Submittals". The aforementioned amount will be retained by the Owner as the agreed estimated value of the approved technical manuals. Any such retention of money for failure to submit the approved technical manuals on or before the seventy-five percent (75%) construction completion point shall be in addition to the retention of any payments due to the Contractor as specified in Article 4 of the Contract.

E. Releases from all parties who are entitled to claims against the subject project, property or improvement pursuant to the provisions of law.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
k. Remove labels that are not permanent.
l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
o. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
p. Leave Project clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

    a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Product maintenance manuals.
5. Systems and equipment maintenance manuals.

1.2 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Engineer.

    a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
    b. Enable inserted reviewer comments on draft submittals.

2. Four (4) paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. One set will be provided to the Engineer and three sets to the Owner.

C. Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer will return copy with comments.

1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information.

B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

C. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Engineer.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

D. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

E. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily

navigated file tree. Configure electronic manual to display bookmark panel on opening file.

G. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.

2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

2.3 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.

3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of operation and maintenance manuals.

F. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.

B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: The Contractor shall submit one (1) set of marked-up record prints to the Engineer.

B. Record Specifications: The Contractor shall submit one paper copy of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit one paper copy of each submittal to the Engineer.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised Drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Record data as soon as possible after obtaining it.
c. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Engineer and Construction Manager. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
3. Refer instances of uncertainty to Engineer through Construction Manager for resolution.
4. Engineer will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.

C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Engineer and Construction Manager.
    e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as paper copy.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as paper copy.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as paper copy.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's and Construction Manager's reference during normal working hours.

END OF SECTION 017839

SECTION 020960 – TEMPORARY BYPASS PUMPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes requirements for implementing a temporary pumping system for the purpose of diverting sewage and process flows around work areas as needed to accomplish the work.

B. The Contractor shall maintain the sewage and process flows through the existing system at all times during construction. Sewage and process flows shall not be allowed to back up and surcharge within the system. To accomplish this, bypass pumping of sewage and process flows may be required by the Contractor. Section 2.3 identifies potential areas of work where temporary bypass pumping may be required. Contractor shall determine where additional bypass pumping associated with the project work is required and shall provide additional bypass pumping at no additional cost to the Owner.

C. The Contractor shall coordinate all bypass pumping work with the Owner or Owner's Representative.

D. If bypass pumping is required or desired, the requirements of this section shall apply.

1.2 QUALITY ASSURANCE

A. Follow national standards and as specified herein.

B. Perform leakage and pressure tests on discharge piping using clean water, before operation. Notify Engineer 24 hours prior to testing.

C. Maintain and inspect temporary pumping system every two hours. The Contractor shall have a responsible operator on site when pumps are operating.

D. Keep and maintain spare parts for pumps and piping on site, as required.

E. Maintain adequate hoisting equipment and accessories on site for each pump.

1.3 SUBMITTALS

A. Submit the following in accordance with Section 013300.

1. Detailed plan and description of proposed pumping system. Indicate number, size, material, location and method of installation of suction and discharge piping, size of pipeline or conveyance system to be bypassed, staging area for pumps, site access point, and expected flow.
    a. Size and location of manhole or access points for suction and discharge hose or piping.
    b. Sections showing suction and discharge pipe depth, embedment, select fill and special backfill, if buried.

c. Temporary pipe supports and anchoring required.
d. Thrust and restraint block sizes and locations.
e. Sewer plugging method and type of plugs.
f. Bypass pump sizes, capacity, number of each size to be on site and power requirements.
g. Backup pump, power and piping equipment.
h. Calculations of static lift, friction losses, and flow velocity. Pump curves showing pump operating range.
i. Design plans and computation for access to bypass pumping locations indicated on drawings.
j. Calculations for selection of bypass pumping pipe size.
k. Method of noise control for each pump and/or generator.
l. Method of protecting discharge manholes or structures from erosion and damage.
m. Schedule for installation and maintenance of bypass pumping lines.
n. Procedures to monitor upstream mains for backup impacts.
o. Procedures for setup and breakdown of pumping operations.
p. Emergency plan detailing procedures to be followed in event of pump failures, sewer overflows, service backups, and sewage spillage.
q. List of equipment for spill containment and cleanup.

2. Maintain copy of emergency plan on site for duration of project.

B. Certify bypass system will meet requirements of codes, and regulatory agencies having jurisdiction.

1.4 CONTRACTORS RESPONSIBILITY FOR OVERFLOWS AND SPILLS

A. Schedule and perform work in manner that does not cause or contribute to incidence of overflows, releases or spills of sewage from sanitary sewer system or bypass operation.

1.5 DELIVERY AND STORAGE

A. Transport, deliver, handle, and store pipe, fittings, pumps, ancillary equipment and materials to prevent damage and following manufacturer's recommendations.

1. Inspect all material and equipment for proper operation before initiating work.

B. For material found to be defective or damaged due to manufacturer or shipment;

1. When repairable: Repair as recommended by manufacturer.
2. When not repairable: Replace before initiating work.
3. Repair or replacement of defective or damaged material and equipment will be at no cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Discharge and Suction Pipes: Approved by Engineer.

1. Discharge piping: Determined according to flow calculations and system operating calculations.
2. Suction piping: Determined according to pump size, flow calculations, and manhole/structure depth following manufacturer's specifications and recommendations.

B. Polyethylene Plastic Pipe:

1. High density solid wall and following ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-DR) based on Outside Diameter, ASTM D1248 and ASTM D3550.
2. Homogenous throughout, free of visible cracks, discoloration, pitting, varying wall thickness, holes, foreign material, blisters, or other deleterious faults.

C. High-Density Polyethylene (HDPE).

1. Homogenous throughout, free of visible cracks, discoloration, pitting, varying wall thickness, holes, foreign material, blisters, or other deleterious faults.
   a. Defective areas of pipe: Cut out and joint fused as stated herein.
2. Assembled and joined at site using couplings, flanges or butt-fusion method to provide leak proof joint. Follow manufacturer's instructions and ASTM D 2657.
   a. Threaded or solvent joints and connections are not permitted.
3. Fusing: By personnel certified as fusion technicians by manufacturer of HDPE pipe and/or fusing equipment.
4. Butt-fused joint: True alignment and uniform roll-back beads resulting from use of proper temperature and pressure.
   a. Allow adequate cooling time before removal of pressure.
   b. Watertight and have tensile strength equal to that of pipe.
   c. Acceptance by Engineer before insertion.

D. Flexible Hoses and Associated Couplings and Connectors.

1. Abrasion resistant.
2. Suitable for intended service.
3. Rated for external and internal loads anticipated, including test pressure.
   a. External loading design: Incorporate anticipated traffic loadings, including traffic impact loading.
4. When subject to traffic loading, compose system, such as traffic ramps or covers.
   a. Install system and maintain H-20 loading requirements while in use or as directed by the Engineer.

E. Valves and Fittings: Determined according to flow calculations, pump sizes previously determined, and system operating pressures.

F. Plugs: Selected and installed according to size of line to be plugged, pipe and manhole configurations, and based on specific site.

1. Additional plugs: Available in the event a plug fails. Plugs will be inspected before use for defects which may lead to failure.

G. Aluminum "irrigation type" piping or glued PVC piping will not be permitted.

H. Discharge hose will only be allowed in short sections when approved by Engineer.

2.2 EQUIPMENT

A. Pumps.

1. Fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in priming system.
2. Electric or diesel powered.
    a. Diesel powered equipment shall be supplied with hospital grade mufflers for noise suppression. Equipment shall meet air quality exhaust criteria of the local Air Pollution Control District as applicable.
3. Constructed to allow dry running for long periods of time to accommodate cyclical nature of influent flows.

B. Provide.

1. Necessary stop/start controls for each pump.
2. One standby pump of each size maintained on site.
    a. On-line, isolated from primary system by a valve.
3. Quiet flow pumps.

2.3 DESIGN REQUIREMENTS

A. The anticipated flow in areas that may require bypass pumping is given based on historical plant influent and/or process flows. Please note that the plant flows are not constant and vary during any given day and/or season. Bypass pumping will be required to accommodate hourly flow variations based on influent flow received at the treatment facility. The anticipated flow range can vary from 4 MGD to 15 MGD depending on the time of day and season.

B. Provide pipeline plugs and pumps of adequate size to handle peak flow, and temporary discharge piping to ensure total flow associated with structures can be safely diverted around structures to be constructed or modified.

PART 3 - EXECUTION

1.1 PREPARATION

A. Determining location of bypass pipelines.
    1. Minimal disturbance to existing utilities and facilities.
        a. Field locate existing utilities in proposed bypass area including convenient points.
    2. Obtain Engineer’s approval of location.

1.2 INSTALLATION AND REMOVAL

A. Provisions and requirements must be reviewed by Engineer before starting construction.

B. Construct temporary bypass pumping structures and make connections to existing and/or newly constructed structures requiring bypass pumping and as required to provide adequate suction conduit.

C. Plugging or blocking of sewage flows shall incorporate a primary and secondary plugging device. When plugging or blocking is no longer needed for performance and acceptance of work, remove in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

D. When working inside structure and manholes, exercise caution. Follow OSHA, Local, State and Federal requirements. Take required measures to protect workforce against sewer gases and/or combustible or oxygen-deficient atmosphere.

E. Installation of Bypass Pipelines:

1. Pipeline may be placed along shoulder of roads and access ways.
2. If a pipeline must be placed across a roadway and/or access way provide adequate roadway maps suitable for expected traffic loads associated with normal plant operations and construction traffic.
3. Following Engineer's approval, the contractor may place bypass piping in trenches and cover with temporary pavement.

F. During bypass pumping operation, protect existing utilities and infrastructure from damage inflicted by equipment.

G. Upon completion of bypass pumping operations, and after the receipt of written permission from Engineer, remove piping, restore property to pre-construction condition and restore pavement.

1.3 MEASUREMENT AND PAYMENT

A. Except as otherwise specified herein, providing for and complying with requirements in this Section will not be measured for payment, but cost will be considered incidental to Contract.

END SECTION

SECTION 024116 - STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of structures and site improvements.
2. Abandoning in-place below-grade construction.
3. Disconnecting, capping or sealing, and abandoning in-place site utilities.
4. Salvaging items for reuse by Owner.

1.2 MATERIALS OWNERSHIP

A. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit informational report, including Drawings, that indicates the measures proposed for protecting individuals and property. Indicate proposed locations and construction of barriers.

B. Schedule of structure demolition with starting and ending dates for each activity.

C. Inventory of items to be removed and salvaged.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

C. Pre-demolition Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

A. Structures to be demolished will be vacated and their use discontinued before start of the Work.

B. Owner assumes no responsibility for buildings and structures to be demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
2. Before building demolition, Owner will remove the following items:

a. As specified in drawings.

C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. Hazardous materials will be removed by Owner before start of the Work.
2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

D. On-site storage or sale of removed items or materials is not permitted.

E. Arrange demolition schedule so as not to interfere with Owner's on-site operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soils: Comply with requirements in Section 312000 "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

A. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
4. Cut off pipe or conduit a minimum of 24 inches below grade unless indicated otherwise. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.

5. Do not start demolition work until utility disconnecting and sealing have been completed.

B. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.

C. Salvaged Items:

1. Clean salvaged items of dirt and demolition debris.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to storage area selected by Owner (within the WRF)
5. Protect items from damage during transport and storage.

3.3 PROTECTION

A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Section 015000 "Temporary Facilities and Controls."

1. Protect adjacent buildings and facilities from damage due to demolition activities.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
4. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
5. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.

D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.4 DEMOLITION

A. General: Demolish indicated buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations.

1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
2. Maintain adequate ventilation when using cutting torches.

3. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Site Access and Temporary Controls: Conduct structure demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.

C. Explosives: Use of explosives is not permitted.

D. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

E. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

F. Salvage: Items to be removed and salvaged are indicated on Drawings.

G. Demolish foundation walls and other below-grade construction within footprint of new construction and extending 5 feet outside footprint indicated for new construction.

1. Remove below-grade construction, including basements, foundation walls, and footings, completely.

H. Existing Utilities: Demolish existing utilities and below-grade utility structures within 5 feet outside footprint indicated for new construction. Cut utilities flush with grade.

I. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in Section 312000 "Earth Moving."

J. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

K. Promptly repair damage to adjacent buildings caused by demolition operations.

3.5 CLEANING

A. Remove demolition waste materials from Project site.

B. Do not burn demolished materials.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

END OF SECTION 024116

SECTION 032000 - REINFORCEMENT STEEL

PART 1 - GENERAL

1.1 THE REQUIREMENT:

A. The Contractor shall furnish, fabricate and place all concrete and masonry reinforcement steel, including all the tie wires, clips, supports, chairs, spacers and other accessories, all as shown and specified in the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Contractor Submittals. 013000

B. Cast-In-Place Concrete. 033000

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS:

A. Codes:

The Building Code, as referenced herein, shall be the latest International Building Code (IBC).

B. Commercial Standards:

ACI 315	Details and Detailing of Concrete Reinforcement.
ACI 318-14	Building Code Requirements for Reinforced Concrete.
ACI 350-06	Code Requirements for Environmental Engineering Concrete Structures.
WRI	Manual of Standard Practice for Welded Wire Fabric.
AWS D1.4-11	Structural Welding Code - Reinforcing Steel.
ASTM A 82	Specification for Steel Wire, Plain, for (Latest Edition) Concrete Reinforcement.
ASTM A 185	Specification for Welded Steel Wire Fabric (Latest Edition) for Concrete Reinforcement.
ASTM A 615	Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
CRSI	Manual of Standard Practice (Latest Edition)
CRSI	Placing Reinforcing Bars (Latest Edition)

1.4 CONTRACTOR SUBMITTALS:

A. The Contractor shall furnish to the Engineer reinforcing steel placing drawings. These drawings shall show the number, grade, size, length, mark, location and bending diagrams for all reinforcing steel and related products, together with lists of bent and straight bars in accordance with the ACI Detailing Manual (latest edition) of the American Concrete Institute and the requirements specified herein and shown on the Contract Drawings. The Engineer may or may not review the placement drawings. Any review of the placement drawings by the Engineer will be limited to general compliance with the Contract Documents and will not be returned to the Contractor. Reinforcing steel placement will be checked in the field using the design drawings. Any discrepancies, errors or omissions from the requirements of the Contract Documents shall be corrected prior to placement of concrete and at the sole expense of the Contractor.

1.5 QUALITY ASSURANCE:

A. If requested by the Engineer, the Contractor shall provide a certified copy of the mill test report showing physical and chemical analysis for each heat of reinforcement steel delivered.

PART 2 - PRODUCTS

2.1 REINFORCEMENT STEEL:

A. Reinforcement steel for all cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement with supplementary requirement S-1, or as otherwise shown.

2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 and the details shown. Welded wire fabric with longitudinal wire equal to or less than 4.0 size wire shall be either furnished in flat sheets or in rolls with a core diameter or not less than 10-inches. Welded wire fabric with longitudinal wires larger than 4.0 size shall be furnished in flat sheets only.

3. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A 82.

B. Accessories:

1. The Contractor shall furnish and install all accessories including necessary chairs or bolsters, concrete blocks (dobies), tie wires, supports, spacers and other devices to position reinforcement during concrete placement.

2. Wire bar supports shall be made of plain cold-drawn steel wire with pre-molded, gray-colored, plastic tips to the legs of the support. The plastic shall have a thickness of 1/8-inch or greater at points of contact with formwork and extend upward on the wire a minimum of 1/2-inch. Wire sizes and geometric dimensions shall be made in accordance with Table II of the latest edition of CRSI Manual of Standard Practice.

3. Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher compressive strength as specified for the concrete in which it is located. Where the concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.

4. The wire tie shall be 16-gauge or heavier, black annealed.

2.2 MECHANICAL COUPLERS:

A. Mechanical couplers shall be provided where shown and where approved by the Engineer. The couplers shall develop a tensile strength which exceeds one hundred fifty percent (150%) of the yield strength of the reinforcement bars being spliced at each splice.

PART 3 - EXECUTION

3.1 GENERAL:

A. All reinforcement steel, welded wire fabric, couplers and other appurtenances shall be fabricated and placed in accordance with the requirements of the Contract Documents, including referenced specifications, codes and standards.

3.2 FABRICATION:

A. Reinforcement steel shall be accurately fabricated to the dimensions and shape shown in the Contract Documents. Fabricating details shall be prepared in accordance with ACI 315, ACI 318, and ACI 350 except as modified by the Drawings. Bends shall conform to bend dimensions defined as standard in accordance with details in the ACI Detailing Manual and/or CRSI Manual of Standard Practice, unless otherwise shown. Bars shall be bent cold and shall not be bent or straightened in a manner that will injure the material. All hooks shall conform to bend dimensions defined as ACI Standard Hooks.

B. The Contractor shall fabricate reinforcement bars within the tolerances shown in the ACI Detailing Manual and/or CRSI Manual of Standard Practice.

C. Reinforcing bars delivered to the field shall be tagged with durable material and marked in a legible manner with waterproof markings. Tags shall show the grade, number of pieces, size and mark or length of bars.

3.3 PLACING:

A. Reinforcing steel shall be accurately positioned as shown on the Contract Documents and shall be adequately supported and wired together to prevent displacement. All reinforcement steel shall be supported or spaced off the forms by concrete or metal supports which are rigid enough to prevent any displacement or the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement. Concrete blocks shall not be used as spacers between mats. All concrete blocks used to space reinforcement steel off vertical formed surfaces shall be tied to the steel with wire ties which are embedded in the blocks. For

reinforcement including welded wire fabric over formwork, the Contractor shall furnish concrete or metal supports with plastic covered legs for bar supports.

B. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

C. Bars additional to those shown which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at its own expense.

D. Placing Tolerances: Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 or ACI 318, except where in conflict with the requirements of The Building Code.

E. Bars may need to be moved to avoid interference with other reinforcement steel, conduits or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer. Additional bars may be necessary to prevent cracking or provide additional reinforcement in this case and shall be provided by the Contractor at its own expense.

F. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than three (3) feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

3.4 SPACING OF BARS:

A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than 1-inch.

B. Where reinforcement in beams or girders is placed in two (2) or more layers, the clear distance between layers shall be not less than 1-inch.

C. In columns, the clear distance between longitudinal bars shall not be less than 1-1/2 times the bar diameter, more less than 1-1/2 times the maximum size of the coarse aggregate, more less than 1-1/2 inches.

3.5 SPLICING:

A. General: Reinforcement bar splices shall only be used at locations shown, unless otherwise acceptable to the Engineer. Reinforcing bar in concrete marked as continuous shall be spliced with a lap of at least 48 bar diameters and no less than 24” for building structures.

B. Splices of Reinforcement: The length of lap for reinforcement bars, shall be in accordance with Contract Drawings for non-building structures (i.e. DAFT, Secondary Clarifiers, Equalization Basin, etc.)

C. Laps of welded wire fabric shall be in accordance with ACI 318 and ACI 350. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each two (2) running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

D. Bending or Straightening: Reinforcement shall not be straightened or re-bent in a manner which will injure the material. Bars with kinks or bends not shown shall not be used. All bars shall be bent cold, unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be field-bent, except as specifically permitted by the Engineer.

3.6 CLEANING AND PROTECTION:

A. Reinforcing steel delivered to the jobsite shall be suitably stored off the ground and protected from oils, mud, concrete splatter and all conditions conducive to corrosion until embedded in concrete.

B. The surfaces of all reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be re-inspected and, if necessary, re-cleaned.

END OF SECTION 032000

SECTION 032900 – JOINTS IN CONCRETE

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall construct all construction joints, expansion joints and control joints in concrete at the locations shown (where not shown the Contractor shall submit joint layout for Engineer's approval) and formed in accordance with the details shown in the drawings.

B. Waterstops shall be provided in all construction and expansion joints of hydraulic or below grade structures unless specifically noted otherwise on the drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-In-Place Concrete. 033000
B. Joint Sealants. 079200

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Federal Specifications:

TT-S-00227E	Sealing Compound, elastomeric type, multi-component (for Caulking, Sealing, Glazing Buildings and Other Structures)

B. Commercial Standards:

ASTM C 920-86	Specification for Elastomeric Joint Sealants
ASTM D 624-81	Test Method for Rubber Property - Tear Resistance
ASTM D 1752-84	Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

1.4 CONTRACTOR SUBMITTALS

A. Waterstop: Prior to production of the waterstop material required under this Contract, the Contractor shall submit for review complete product data, including qualification samples of extruded sections of each size and shape to be used, catalogue cut, technical data, storage requirements, and splicing methods.. The submittal shall also include the manufacturer's certification that the water stop material meets the physical requirements as outlined under paragraph 2.1, herein.

1.5 QUALITY ASSURANCE

A. Waterstop Inspection: Waterstop installation shall be subject to rigid inspection. No waterstop shall be cast in concrete without the Engineer's observation. Not less than twenty-four (24) hours notice shall be provided to the Engineer for scheduling such inspections.

B. Waterstop Field Samples: Prior to use of the waterstop material in the field, a sample of a fabricated mitered cross and a tee constructed of each size or shape of material to be used shall be submitted to the Engineer for review. These samples shall be fabricated so that the material and workmanship represent in all respects the fittings to be furnished under this Contract. Field samples of fabricated fittings (crosses, tees, etc.) may be selected at random by the Engineer for testing by a laboratory at the Owner's expense. When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

C. All field joints in waterstops shall be subject to rigid inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets and other defects. All defective joints shall be replaced and all weathered, damaged or otherwise faulty material shall be removed from the site and disposed of by the Contractor at its own expense.

D. Waterstops shall be stored on site where it will not be subjected to freezing temperatures or exposed to the direct rays of the sun.

E. Construction Joint Sealant: The Contractor shall prepare adhesion and cohesion test specimens as specified herein from each shipment of material received at the jobsite. Sealant shall be stored at room temperature and shall not be stored longer than seventy-five percent (75%) of the manufacturer's stated shelf life.

F. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure:

1. Sealant specimen shall be prepared between two concrete blocks (1-inch by 2-inch by 3-inch). Spacing between the blocks shall be 1/2-inch. Coated spacers (2-inch by 1-1/2 inch by 1/2-inch) shall be used to ensure sealant cross-sections of 1/2-inch by 2-inches with a width of 1/2-inch.

2. Sealant shall be cast and cured according to manufacturer's recommendations except that curing period shall not exceed twenty-four (24) hours.

3. Following curing period, the gap between blocks shall be widened to 1-inch. Spacers shall be used to maintain this gap for twenty-four (24) hours prior to inspection for failure.

1.6 GUARANTEE

A. The Contractor shall provide a three (3) year written guarantee of the entire joint sealant and waterstop installations against faulty and/or incompatible materials and workmanship, together with a statement that it agrees to repair or replace, to the satisfaction of the Owner, at no additional cost to the Owner, any such defective areas which become evident within said three (3) year guarantee period.

PART 2 - PRODUCTS

2.1 PVC WATERSTOPS

A. General: Waterstops shall be extruded from an elastomeric plastic compound consisting of virgin polyvinylcloride and additional plasticizers and stabilizers necessary to meet or exceed the requirements and performance criteria of these Specifications and the Corps of Engineers Specifications CRD-C572. No reclaimed scrap or reprocessed material shall be used.

B. Flatstrip, and Multi-Rib Waterstops: Flatstrip, center-bulb and multi-rip waterstops shall be detailed and as manufactured by: Vinylex Corp or approved equal; provided, that at no place shall the thickness of flat strip waterstops, including the center-bulb type, be less than 3/8-inch. Prefabricated joint fittings shall be used at all intersections of the ribbed-type waterstops.

C. Physical Properties: When tested in accordance with the specified test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	Value	ASTM Test Method
Tensile Strength-Min (psi)	1750	D 638
Ultimate Elongation-Min (percent)	350	D 638
Low Temp. Brittleness-Max (-35 Deg F)	Pass	D 746
Stiffness in Flexure-Min (psi)	400	D 747
Accelerated Aging (CRD-C572)		
Tensile Strength-Min (psi)	1500	D 638
Ultimate Elongation-Min (percent)	300	D 638

2.2 HYDROPHILIC WATERSTOPS

A. Hydrophilic waterstops where shown on the Drawings, shall be Adeka Ultra Seal MC-2010 MN, Greenstreak "Hydrotite" Hydrophilic rubber waterstops or equal. Hydrophilic waterstops shall be installed according to the manufacturer's recommendations.

B. Physical Properties: When tested in accordance with the specified test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property	Value	ASTM TEST Method
Hardness	30	2240
Tensile Strength	100	D412
Elongation %	500	D412
Specific Gravity	1.18	D792

C. Hydrophilic Paste: Where required, use a paste to adhere the waterstop to the surface. Paste shall be Adeka P-201 or equal. Paste shall be applied according to the manufacturer's recommendations.

2.3 JOINT SEALANTS

A. Joint sealant shall be Sikaflex 2c NS or equal. Where sealant is applied in areas to be submerged in liquid, Sikaflex Primer-429 or equal shall be applied first. Contractor shall follow the manufacturer's recommended application methods.

PART 3 - EXECUTION

3.1 GENERAL

A. Unless otherwise shown, waterstops of the type specified herein, shall be fully continuous for the extent of the joint. The Contractor shall take suitable precautions and means to support and protect the waterstops during the progress of the work and shall repair or replace at its own expense any waterstops damaged during the progress of the work.

B. Suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure and until the exposed portion of the waterstop is embedded in concrete.

C. Splices in waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations. It is essential that the splices have a tensile strength of not less than sixty percent (60%) of the unspliced materials tensile strength and the continuity of the waterstop ribs and of its tubular center axis be maintained.

3.2 INSTALLATION OF WATERSTOP

A. All joints with waterstops involving more than two (2) ends to be jointed together and all joints which involve an angle cut, alignment change or the joining of two (2) dissimilar waterstop sections shall be prefabricated by the Contractor prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint. Upon being inspected and approved, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt welded to the straight run portions of waterstop in place in the forms.

B. Adequate provisions must be made to support the waterstops during the progress of the work and to ensure the proper embedment in the concrete. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints. The center axis of the waterstops shall be coincident with the joint openings. Maximum density and imperviousness of the concrete shall be ensured by thoroughly working it in the vicinity of all joints.

B. Adequate means shall be provided to prevent waterstops from being folded over by the concrete as it is placed. Unless otherwise shown, all waterstops shall be held in place with light wire ties on 12-inch centers which shall be passed through the edge of the waterstop and tied to the curtain of reinforcing steel. In placing concrete around horizontal waterstops, with their flat face in a horizontal plane, concrete shall be carefully worked under the waterstops so as to avoid the formation of air and rock pockets.

3.3 JOINT CONSTRUCTION

A. Joint Location: Construction joints and control joints shall be provided where shown on Drawings or as approved by the Engineer. Do not eliminate or relocate control joints. Any additional or relocation of construction joints proposed by the Contractor must be submitted to the Engineer for written approval. The location of all joints shall be submitted for acceptance by the Engineer.

B. Construction Joints

1. Locate additional or relocated joints where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams and girders. However, if a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at tops of footings or floor slabs. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them

2. At all construction joints and at concrete joints indicated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points and side to side) of 1/4-in with chipping tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, saturate the joints with water. After glistening water disappears, coat joints with neat cement slurry mixed to the consistency of very heavy paste. The surfaces shall receive a coating at least 1/8-in thick, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before the neat cement dries.

3. Unless indicated otherwise, provide joints perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings.

4. Provide waterstops in wall and slab construction joints in liquid retaining structures and at other locations shown on the Drawings.

5. Do not use keyways in construction joints unless specifically shown on the Drawings or approved by the Engineer.

C. Control Joints

1. Make control joints at locations shown on the Drawings. Do not eliminate or relocate control joints.

2. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings. Coat the concrete surface with a bond breaker prior to placing new concrete against it as shown on the Drawings. Do not cast reinforcement with bond breaker.

D. Sealant

1. Install sealants in clean dry recesses free of frost, oil, grease, form release agent, loose material, laitance, dirt, dust and other materials which will impair bond at the locations shown on the Drawings. Apply sealant conforming to the manufacturer's recommendations including concrete cure, temperature, moisture, mixing, primer, primer cure time, joint and

recess preparation, tooling, and curing. Apply masking tape to each side of the joint prior to the installation of the sealant and remove afterwards along with any spillage to leave a sealant installation with neat straight edges.

2. Sealant grooves shall be formed as shown on the drawings and shall be protected from damage until final application of the sealant. Care shall be taken to prevent chipping of the sealant grove during removal of forms.

E. Special care shall be used in preparing concrete surfaces at joints where bonding between two (2) sections of concrete is required. Unless otherwise shown, such bonding will be required at all horizontal joints in walls and wall to slab joints. Surfaces shall be prepared by sandblasting and washing for removal of laitance or any objectional material. Joints shall be kept clean until the concrete is placed. Vertical joints shall be clean and free of concrete fins, rock pockets or any objectional material.

END OF SECTION 032900

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Sections:

1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: Before placing any concrete, the Contractor shall submit to the Engineer, for review, the complete details of all concrete mix designs which he proposes to use including proportions and gradations of all materials for each class and type of concrete specified herein. The mix designs shall be designed by a certified testing laboratory acceptable to the Engineer. The mix design submittal shall also include test results from at least one (1) trial batch of each class and type concrete. From each trial batch six (6) 6-inch X 12-inch test cylinders shall be cast in accordance with ASTM C 31. Three (3) of these cylinders shall be compression tested in accordance with ASTM C 39 at 7-days and the other three (3) at 28-days. Test results shall include full information on each cylinder as to mix and slump in accordance with ASTM C 143. Three (3) drying shrinkage specimens shall also be cast and tested in accordance with ASTM C 157 on each type of structural concrete mix design. All costs for such mix design including mix design tests shall be borne by the Contractor.

C. If fly ash concrete is proposed by the concrete supplier, the Contractor shall submit to the Engineer for review the design mix for fly ash concrete together with the design mix for Portland Cement (non-fly ash) concrete as specified in this Section. The Contractor shall furnish a Certificate of Compliance signed by the supplier identifying the type of fly ash and stating that the fly ash complies with ASTM C 618 and these specifications, together with all supporting test data including a certified chemical and physical analysis report prior to the use of the fly ash the sample represents. The supporting data shall also contain test results confirming that the fly ash in combination with the cement and water to be used meets all strength requirements and is compatible with air-entraining agents and other admixtures.

D. When a water-reducing admixture is to be used, the Contractor shall furnish mix designs for concrete both with and without the admixture.

E. Delivery Tickets: Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate,

cement, fly ash, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.

F. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.

G. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

H. Welding certificates.

I. Material certificates.

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.

2. Certify that the Contractor is not associated with the independent testing laboratory proposed for use by the Contractor nor does the Contractor or officers of the Contractor's organization have a beneficial interest in the laboratory.

3. Certify that cement is produced by a manufacturer that does not use hazardous waste derived fuel as an energy source for its kilns.

4. Certificate of conformance for concrete production facilities from the NRMCA.

J. Material test reports.

1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.

2. Cement and fly ash: Conformance to ASTM standards, including chemical analysis and physical tests.

3. Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash. Provide for each mix proposed.

a. Standard deviation data for each proposed concrete mix based on statistical records.

Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:

1) Date of sampling and name of testing laboratory.
2) Name of concrete batch plant.
3) Water cementitious ratio.
4) Slump of batch.
5) Air content of batch.

6) 28 day compression test results.
7) If available, temperature and unit weight of batch.

Provide data from projects not more strictly controlled than outlined in these specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation.

4. Concrete Mixes: shrinkage.

K. Floor surface flatness and levelness measurements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

2. ASTM C33 - Standard Specification for Concrete Aggregates.

3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.

6. ASTM C 109 Standard Test Method for Compressive (Latest Edition) Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens)

7. ASTM C138 – Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.

8. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete

9. ASTM C150 - Standard Specification for Portland Cement

10. ASTM C156 - Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compound for Concrete

12. ASTM C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.

13. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete

14. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

15. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.

16. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

17. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

18. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

19. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use in Portland Cement Concrete.

20. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.

21. ASTM C596 - Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.

22. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

23. ASTM C-827-87 Standard Test Method for Early Volume Change of Cementitious Mixtures

24. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

25. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.

26. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).

27. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.

B. American Concrete Institute (ACI).

1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

2. ACI 232.2R - Use of Fly Ash in Concrete.

3. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.

4. ACI 304.2R - Placing Concrete by Pumping Methods.

5. ACI 305R - Hot Weather Concreting.

6. ACI 306R - Cold Weather Concreting.

7. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

8. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.

C. National Ready Mixed Concrete Association (NRMCA)

1. Quality Control Manual, Section 3 - Certification of Ready Mixed Concrete Production Facilities.

D. Truck Mixer Manufacturers Bureau (TMMB)

1. TMMB 100 - Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.

E. Corps of Engineers Specification

1. CRD-C 621-85 Corps of Engineers Specification for Non-Shrink Grout

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Name and address.

2. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.

3. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.

4. Names and qualifications of the supervising laboratory technicians.

5. Statement of conformance provided by evaluation authority defined in ASTM C1077. Provide report prepared by evaluation authority when requested by the Engineer.

6. Submit as required above for other organizations that will provide external technical services.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

F. Preinstallation Conference: Conduct conference at Project site.

G. Mix design tests on component materials and for compressive strength and shrinkage of concrete shall be performed as specified herein. The mix shall not at any time be changed without approval of the Engineer, except that at all times the batching of fine aggregate shall be adjusted to compensate for the moisture content. Satisfactory means shall be provided at the batching plant for checking the moisture content of the fine aggregate. The details of concrete mixes submitted for approval shall include information on the correction of the batching for varying moisture contents of the fine aggregate.

To avoid unnecessary or haphazard changes in consistency, the aggregate shall be obtained from a source which will ensure a uniform quality.

H. During the progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with the standards of quality specified herein. These tests will be made in accordance with ASTM C 31, ASTM C 39, ASTM 179 and ASTM C 157. The testing expense during construction, except for the trial batch or mix design testing, will be borne by the Owner. The Contractor shall take sets of field control cylinder specimens during the progress of the work in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete place each day shall comply with the requirements of the International Building Code (IBC).

I. Specimens shall be formed in 6-in by 12-in long non-absorbent cylindrical molds.

1. A “set” of test cylinders shall consist of five cylinders; one to be tested at seven days, one to the tested at 14 days, and two to be tested and their strengths averaged at 28 days. The fifth may be used for a special test at 3 days or to verify strength after 28 days if 28 day test results are low.

J. Testing agency shall provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold ten specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to the testing lab. Protect the specimens against injury or loss through construction operations.

K. Concrete for testing shall be supplied by the Contractor at no cost to the Owner, and the Contractor shall provide assistance to the Engineer in obtaining samples and disposal and cleanup of excess material.

L. Evaluation and Acceptance of Concrete:

1. Concrete is expected to reach a higher compressive strength than that which is indicated in Paragraph 2.8., as compressive strength. The strength level of the concrete will be considered satisfactory if the average strength of the two (2) 28-day specimens equals or exceeds the required strength and no individual specimen strength falls below the required strength by more than 500 psi. Where an individual strength test falls below the required strength by more than 500 psi, the Engineer shall have the right to ask for cores taken in accordance with ASTM C 42 and ACI 318, all at the Contractors expense.

2. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected. Any and all corrective actions shall be at no additional cost to the Owner.

3. All concrete which fails to meet the ACI requirements and these specifications, is subject to removal and replacement at the cost of the Contractor.

M. Test slump immediately prior to placing the concrete. Test shall be made in accordance with ASTM C143. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.

N. Test for air content shall be conducted on a fresh concrete sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If aggregates with high absorptions are used, the latter test method shall be used. When concrete is pumped, air content will be determined at point of placement.

O. Shrinkage Tests: Shrinkage tests will be made during construction to ensure continued compliance with these specifications.

P. Ready-mix concrete shall conform to the requirements of ASTM C 94.

Q. The Engineer shall have access to and have the right to inspect all batch plants, cement mills and supply facilities providing products under these specifications. Batch plants shall have current certificates that all scales have been tested and are certified within the tolerances as set forth in the National Bureau of Standards Handbook No. 44.

R. Construction Tolerances: The Contractor shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades or dimensions shown. Where tolerances are not stated in these specifications, permissible deviations will be in accordance with ACI 347. Where tolerances are not met, the concrete shall be repaired or replaced at the Contractor's expense until the tolerances are met.

The following construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

Structural Component	Tolerance
Variation of the constructed linear outline from the	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.

established position in plan.

Variation from the level or from the grades shown.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.
Variation from the plumb.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.
Variation in the thickness of slabs and walls.	Plus 1/4-inch; Plus 1/2-inch.
Variation in the locations and sizes of slab and wall openings.	Plus or minus 1/4-inch.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

D. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from galvanized-steel wire into flat sheets.

E. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1 steel.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type V, Low Alkali. Supplement with the following:

    a. Fly Ash: ASTM C 618, Class F , including the requirements of Section 2.8 but with the Loss of Ignition (LOI) limited to 3 percent maximum and the optional physical requirements of Table 3. Test in compliance with ASTM C311 with a minimum of one sample weighing four pounds taken from each 200 tons of fly ash supplied for the project.
    b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
    c. Portland Cement shall contain not more than 0.60 percent total alkalies. The term "alkalies" is defined as the sum sodium oxide (Na_2O), potassium oxide (K_2O), calculated as sodium oxide (.658 K_2O). Only one (1) brand of cement shall be used for exposed concrete in any individual structure. The cement shall be suitably protected from exposure to moisture until used. Certified mill test reports for each shipment of cement to be used shall be submitted to the Engineer. Mill test reports shall include the alkali content. Do not use cement produced by a manufacturer that uses hazardous waste derived fuel as an energy source for its kilns.
    d. Do not use air entraining cements.

B. Normal-Weight Aggregates: ASTM C 33, graded.

1. Maximum size aggregate in foundations and mass concrete shall be 1 inch. The maximum size aggregate in slabs on grade, walls, and all concrete shall be ¾ inch.

C. Water: ASTM C 94/C 94M and potable. Water shall be clean and free from objectionable quantities of silty organic matter, oils, chlorides, alkali, salts and other impurities. The water shall be considered potable, for the purpose of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/l TDS) shall not be used.

2.4 AGGREGATES

A. All concrete aggregates shall be obtained from pits acceptable to the Engineer, shall be non-reactive, sound, uniformly graded and free of deleterious material in excess of allowable limits specified.

B. Combined aggregates shall be well graded from coarse to fine sizes, and be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Lightweight sand for fine aggregate will not be permitted. Aggregates shall conform to ASTM C 33.

1. Coarse Aggregate: Coarse aggregate shall consist of gravel, crushed gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter or other foreign substances. Thin or elongated pieces having a length greater than four (4) times the average thickness shall not exceed fifteen percent (15%) by weight. Deleterious substances shall not be present in excess of the following percentages by weight, and in no case shall the total of all deleterious substances exceed one and one-half percent (1.5%):

2. Fine Aggregate: Fine aggregate for concrete or mortar shall consist of clean, natural sand or a combination of natural and manufactured sands that are hard and durable. Deleterious substances shall not be present in excess of the following percentages by weight of contaminating substances. In no case shall the total exceed three percent (3%):

   Fine aggregate shall not contain strong alkali nor organic matter which gives a color darker than a standard color when tested in accordance with ASTM C 40. Fine aggregate shall have a fineness modulus not less than 2.50 nor greater than 3.00. Except as otherwise specified, fine aggregate shall be graded from coarse to fine in accordance with the requirements of ASTM C 33.

3. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement proposed for the project. If aggregates proposed for use do not meet this requirement, then satisfy either a. or b. below.

   a. Total equivalent alkali content of the cement used shall not exceed 0.6 percent as provided in the Optional Chemical Requirements of ASTM C150.

   b. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement and fly ash proposed for the project. The proportions of the cement-fly ash mix shall be the same as those proposed for the project.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260. Proportion and mix in accordance with manufacturer's recommendations.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

   1. All concrete shall contain five percent (5%), plus or minus one percent (1%) entrained air of evenly dispersed air bubbles at the time of placement. Air entrainment requirement may be modified or waived following an approval from the Engineer for concrete construction not exposed to freeze/thaw cycles. The air-entraining agent shall contain no chloride and conform to ASTM C 260, or U.S. Army Corps of Engineers Specifications CRD-C13. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. The Engineer, or Owner and his duly authorized representatives reserve the right, at any time, to sample and test the air-entraining agent or the air content of concrete received on the job by the Contractor. Air entrainment in the concrete shall be tested by ASTM C 138, ASTM C 231 or ASTM C 173. If any sample tested does not have the specified air content, a second test shall be performed. If the second test does not meet the specified air content, the concrete represented by the test shall be removed from the job.

2. Retain one or more chemical admixtures from three subparagraphs below.

    a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A. Proportion and mix in accordance with manufacturer's recommendations.
    b. High-Range, Water-Reducing Admixture (Plasticizer): ASTM C 494/C 494M, Type Fresulting in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cementitious ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportion and mix in accordance with manufacturer's recommendations.
    c. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Engineer. Use retarding or accelerating water reducing admixture when so approved,

C. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

D. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

2.6 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet. The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

D. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a normal thickness of 6 mils.

E. Water: Potable.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. The curing compound shall contain a fugitive dye so that areas of application will be readily distinguishable. Compound shall contain no wax, paraffin, or oil. Curing compound shall be non-yellowing and have a unit moisture loss no greater than 0.039 gm/cm^2 at 72 hours as measured by ASTM C156. Curing compound shall comply with Federal, State, and local VOC limits.

2.7 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

2.8 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement. The maximum amount of fly wash used shall be in accordance with ACI 318.

1. Class F Fly Ash
   a. Loss on ignition, maximum 1%
   b. SO3 content, maximum 3%
   c. Moisture content, maximum 1%
   d. R = (CaO - 5%)/(Fe2O3), maximum 1.5

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.45.

D. Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45
3. Minimum Cement W/C per cubic yard (94 lb sacks): 6.0
4. Slump Limit: 3 inches, plus or minus 1 inch or 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
5. Air Content: 6 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size greater than 3/8 inch.
6. Air Content: 7 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size 3/8 inch or less.
7. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
8. Type of Work: Structural Concrete for Walls and Slabs-On Grade

For Pipe Support Footings:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50
3. Minimum Cement W/C per cubic yard (94 lb sacks): 6.0
4. Slump Limit: 3 inches, plus or minus 1 inch or 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.

5. Air Content: 6 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size greater than 3/8 inch.
6. Air Content: 7 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size 3/8 inch or less.
7. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
8. Type of Work: Pipe Support Footings

E. Proportion Lean concrete mixture as follows:

1. Minimum Compressive Strength: 2500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.60
3. Minimum Cement W/C per cubic yard (94 lb sacks): 4.5
4. Slump Limit: 3 inches, plus ½ inch or minus 1 inch or 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
5. Air Content: 5.0 percent, plus or minus 1 percent at point of delivery.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
7. Type of Work: Lean Concrete.

2.9 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2.11 TRIAL BATCH AND LABORATORY TESTS

A. Before placing any concrete, the Contractor shall submit the certified trial batch results of each class of concrete having a 28-day strength of 4,000 psi or higher, based on the preliminary concrete mixes submitted by the Contractor. All concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the Contractors preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement and admixture proposed for the project. . The costs for the trial batch tests shall be borne by the Contractor.

B. The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured and tested in accordance with ASTM C 192 and ASTM C 39. Three (3) compression test cylinders will be tested at 7-days and three (3) at 28-days. The average compressive strength for the three (3) cylinders tested at 28-days for any given trial batch shall not be less than one hundred twenty-five percent (125%) of the specified compressive strength.

C. A standard sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements for ASTM C 136. Values shall be given for percent passing each sieve.

2.12 SHRINKAGE LIMITATION

A. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10-inches, fabricated, cured, dried and measured in accordance with ASTM C 157 modified as follows: Specimens shall be removed from molds at an age of 23± hours after trial batching, shall be placed immediately in water at 70 degrees F. ±3 degrees F. for at least thirty (30) minutes, and shall be measured within thirty (30) minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F. ±3 degrees F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7-days. This length at age 7-days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F. ±3 degrees F. and fifty percent (50%) ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21 and 28-days of drying after 7-days of moist curing.

The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. the average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001-inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing during shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be specified herein.

B. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age (specified in Paragraph 2.07), shall be 0.036 percent or 0.042 percent, respectively. The Contractor shall only use a mix design for construction that has first met the trial batch shrinkage requirements.

C. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than twenty-five percent (25%).

D. If the required shrinkage limitation is not met during construction, the Contractor shall take all necessary action, at not additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water content ratio; washing or aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

2.13 GROUT

A. Grout shall be a mixture of one part Portland cement to 4-1/2 parts sand. Water content shall be such that the grout can be readily spread, yet not wet enough to cause trouble with surface water

or laitance, or failure to stay in place after screeding. All grout mixes and mixing procedures shall be submitted in accordance with section 013300-Contractor Submittals, and shall be subject to review and approval by the Engineer prior to commencing the grouting operations.

B. Procedures for Grout placement shall be approved by the equipment supplier, to insure that no equipment is overstressed, as well as proper placement tolerances. Equipment Supplier shall have final say on grouting procedures and final tolerances.

PART 3 - EXECUTION

3.1 MIXING CONCRETE

A. Mixing equipment shall be subject to the Engineers approval. Mixers shall be of the stationary plant or truck mixer type. Adequate equipment and facilities shall be provided for accurate measurement and control of all materials and for readily changing the proportions of the material. The mixing equipment shall be maintained in good working order and shall be capable of combining the aggregates, cement and water within the specified time into a thoroughly mixed and uniform mass and of discharging the mixture without segregation. Cement and aggregate shall be proportioned by weight.

B. The batch plant shall be capable of controlling and delivering of all material to within one percent (1%) by weight of the individual material. If bulk cement is used, it shall be weighed on a separate visible scale which will accurately register the scale load at any stage of the weighing operation from zero to full capacity.

C. Cement shall not come in contact with aggregate or with water until the materials are in the mixer ready for complete mixing with all mixing water. The procedure of mixing cement with sand or with sand and coarse aggregate for delivery to the jobsite for final mixing and an addition of mixing water will not be permitted. Re-tempering of concrete will not be permitted. The entire batch shall be discharged before recharging. The volume of the mixed material per batch shall not exceed the manufacturers rated capacity of the mixer.

D. Each mixer shall be equipped with a device for accurately measuring and indicating the quantity of water entering the concrete, and the operating mechanism shall be such that leakage will not occur when the valves are closed. Each mixer shall be equipped with a device for automatically measuring, indicating and controlling the time required for mixing. This device shall be interlocked to prevent the discharge of concrete from the mixer before the expiration of the mixing period.

E. Transit-mixed concrete shall be mixed and delivered in accordance with ASTM C 94. After the drum is once started, it shall be revolved continuously until it has completely discharged its batch. Water shall not be admitted to the mix until the drum has started revolving. The right is reserved to increase the required minimum number of revolutions allowed, if necessary, to obtain satisfactory mixing, and the Contractor will not be entitled to additional compensation because of such an increase or decrease.

F. Mixed concrete shall be delivered to the site of the work and discharge shall be completed within one (1) hour after the addition of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the

concrete is 85 degrees F. or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed forty-five (45) minutes. The use of non-agitating equipment for transporting concrete will not be permitted.

G. Truck mixers shall be equipped with counters so that the number of revolutions of the drum may be readily verified. The counter shall be of the resettable type and shall be actuated at the time of starting mixers at mixing speeds. Concrete shall be mixed in a truck mixer for not less than seventy (70) revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolution of mixing.

H. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the ¼ and ¾ points of the load during discharge give slumps differing by more than one inch when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump test. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

I. Comply with ACI 318 and ASTM C94 for all central plant and rolling stock equipment and methods.

J. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with slopes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20-foot long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.

3.2 PREPARATION OR SURFACES FOR CONCRETING

A. Earth surfaces shall be thoroughly and uniformly wetted by sprinkling prior to the placing of any concrete. These surfaces shall be kept moist by frequent sprinkling up to the time concrete is placed thereon. The surface shall be free from standing water, mud and debris at the time of placing concrete.

B. The surfaces of all horizontal construction joints shall be cleaned of all latence, loose or defective concrete and foreign material. Such cleaning shall be accomplished by sandblasting followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.

C. No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel and preparation off surfaces involved in the placing have been completed and accepted by the Engineer at least four (4) hours before placement of concrete. All reinforcement, anchor bolts, sleeves, inserts and similar items shall be set and secured in the forms where shown or by shop drawings and shall be acceptable to the Engineer before any concrete is placed. Accuracy of placement is the responsibility of the Contractor. All surfaces

of embedded items that have become encrusted with dried grout from concrete previously placed shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.

D. All form surfaces in contact with the concrete shall be thoroughly cleaned of all previous concrete, dirt and other surface contaminants prior to use. Damaged form surfaces shall not be used.

Wood form surfaces in contact with the concrete shall be coated with an approved release agent prior to form installation. The release agent shall be non-staining and non-toxic after thirty (30) days. Mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface of steel forms. All steel forms shall have the contact surfaces coated with an approved release agent. The release agent shall be effective in preventing discoloration of the concrete from rust and shall be non-toxic after thirty (30) days.

E. Where concrete is to be cast against old existing concrete, the old concrete shall be thoroughly roughened to exposed, hard aggregate by sandblasting or chipping. Any additional surface preparation shall be as called for in the drawings.

F. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or diverted out of the forms and clear of the work. No concrete shall be deposited under water or allowed to rise on any concrete until the concrete has attained its initial set. Pumping or other necessary dewatering operations for removing ground water, if required, shall be the responsibility of the Contractor and will be subject to review by the Engineer.

G. Pipe, conduit, dowels, sleeves and other ferrous items required to be embedded in concrete construction shall be adequately positioned and supported prior to placement of concrete. There shall be a minimum of 2-inches clearance between embedded items and any of the concrete reinforcement. Securing embeddments in position by wiring or welding them to the reinforcement will not be permitted.

3.3 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete except where grating will be installed.

3.4 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

B. Do not embed piping or electrical conduits in concrete unless shown on the Drawings.

C. Pipes and conduits embedded within a slab or wall (other than those merely passing through) shall satisfy the following, unless otherwise shown on the Drawings or approved:

1. Maximum outside dimension of pipe or conduit shall not be greater than one third the over-all thickness of the slab or wall.

2. Spacing of pipes or conduits shall be greater than or equal to three diameters or widths on center.

D. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.

E. Fabricate piping and conduit such that the cutting, bending, or relocation

F. Pipe, conduit, dowels, sleeves and other ferrous items required to be embedded in concrete construction shall be adequately positioned and supported prior to placement of concrete. There shall be a minimum of 2-inches clearance between embedded items and any of the concrete reinforcement. Securing embeddments in position by wiring or welding them to the reinforcement will not be permitted. Embedded items shall be clean and free of rust, mud, dirt, grease, oil, ice, or other contaminants which would reduce or prevent bonding with concrete.

G. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.

H. Ensure all specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure all mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.

3.5 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.6 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

E. Waterstops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.8 CONCRETE PLACEMENT

A. Placement of concrete shall conform to the requirements and recommendations of ACI 301, 304 and 318, except as modified herein.

B. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

D. Cold-Weather Placement:

1. For this Specification, "cold weather" is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F. Calculate average daily temperature as the average of the highest and the lowest temperature during the period from midnight to midnight.

2. Batch, deliver, place, cure and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.

3. Review the cold weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during cold weather including the production, transportation, placement, protection, curing and temperature monitoring of the concrete

and the procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

4. The minimum temperature of concrete immediately after placement and during the protection period shall be as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non uniform heating of the concrete.

TABLE 3

Concrete Temperatures
Minimum Dimension of Section

	< 12-in	12 to 36-in
Min. conc temp:	55 Degree F	50 Degree F

5. Protect concrete during periods of cold weather to provide continuous warm, moist curing (with supplementary heat when required by weather conditions) for a total of at least 350 degree-days of curing.

   a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 7 days at an average 50 degrees F = 350 degree-days).

   b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.

6. Do not use salt, manure or other chemicals for protection.

7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, do not expose concrete to temperatures below those shown in Table 3 until at least 24 hours after water curing has been terminated and air dry concrete for at least 3 days prior to first exposure to freezing temperatures.

8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 72 hours after placing.

E. Hot-Weather Placement:

1. For this Specification, "hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour (lb/sq ft/hr).

2. Batch, deliver, place, cure and protect concrete during hot weather in compliance with the recommendations of ACI 305R and the additional requirements of this Section.

   a. Temperature of concrete being placed shall not exceed 90 degrees F. Maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.

b. Promptly deliver concrete to the site and promptly place the concrete upon its arrival at the site, not exceeding the maximum time interval specified in Paragraph 3.1F Provide vibration immediately after placement.

c. The Engineer may direct the Contractor to immediately cover concrete with sheet curing material.

3. Review the hot weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during hot weather including production, placement, and curing.

F. No concrete shall be placed without prior inspection of the forms, reinforcing and embedded items and approval from an authorized representative of the Engineer. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. The Contractor shall notify the Engineer at least twenty-four (24) hours in advance of any scheduled concrete placement and shall call for final inspections no later than four (4) hours in advance of the scheduled placement. The Contractor shall notify the Engineer at least two (2) hours in advance of setting the opposite side of wall forms so that the construction joint preparation, water stop installation and reinforcing steel inspections can be conducted. It is the Contractors responsibility to see that the forms are properly cleaned and oiled before being set, the construction joints properly prepared, reinforcing steel is securely and properly supported in the correct position and that all embedment items including electrical conduit is correctly installed before calling for inspections. The Engineer may at his option require the use of placement cords if deemed necessary.

G. Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the work. Concrete which is not placed in accordance with these specifications, or which is of inferior quality, shall be removed and replaced at the expense of the Contractor.

H. No concrete shall be placed during rain or snow storms, unless completely covered to prevent storm water from coming in contact with it. Sufficient protective covering material shall be kept on hand at all times should rain or snow storms arise during concrete placement operations.

I. Concrete shall be deposited at or near its final position to avoid segregation caused by rehandling or flowing. Concrete shall not be deposited in large quantities in one place and worked along the forms with vibrator or other means. Concrete shall be uniformly distributed during the placing process and in no case after depositing shall any portion be displaced in the forms more than 2-feet in horizontal direction. Concrete shall be deposited in forms in horizontal layers not to exceed 24-inches in depth and shall be brought up evenly in all parts of the form. The rate of placement of concrete in forms shall not exceed 5-feet of vertical rise per hour. As the concrete is placed it shall be consolidated thoroughly and uniformly by mechanical vibration to secure a dense mass, close bond with reinforcement and other embedded items and smooth surface. The mechanical vibrator shall penetrate not only the freshly placed concrete, but also the previously placed lift to ensure the lifts become monolith. New concrete shall be placed against previously placed concrete, not away from it. When concrete is placed on a slope, placement shall begin at the lower end of the slope and progress to the upper end for the full width of the placement. Consolidation by mechanical vibration shall follow directly behind placement and the rate of placement shall never get ahead of the consolidation crew. Concrete placement shall continue without avoidable interruption, in a continuous operation until the end of the placement is reached.

J. The drop of concrete into slab or wall forms shall be vertical. Concrete shall not be dropped through reinforced steel, but deposited in forms using a hopper with a drop chute to avoid segregation and to keep mortar from coating the reinforcement steel and forms above the in-place concrete. In no case shall the free fall of concrete exceed 4-feet below the end of the hopper or chute.

K. If it takes more than 20-minutes to get back to place concrete over concrete previously placed, the depth of the layers being placed at one time shall be reduced, and/or placing equipment increased, until it is possible to return with the placing operation to previously placed concrete within 20-minutes. If concrete is to be placed over previously poured concrete and more than 20-minutes have elapsed, then a layer of grout not less than 1/2-inch thick shall be spread over the surface before placing the additional concrete.

L. The placement of concrete for slabs, beams or walkways cast monolithically with walls or columns shall not commence until the concrete in the walls or columns has been allowed to set and shrink. The time allowed for shrinkage shall be not less than one (1) hour.

M. Concrete shall be placed with the aid of approved mechanical vibrators. Vibration shall be supplemented by manual forking or spading adjacent to the forms on exposed faced in order to secure smooth dense surfaces. The concrete shall be thoroughly consolidated around reinforcement, pipes or other shapes built into the work. The vibration shall be sufficiently intense to cause the concrete to flow and settle readily into place and to visibly affect the concrete over a radius of at least 18-inches.

Sufficient vibrators shall be on hand at all times to vibrate the concrete as placed. In addition to the vibrators in actual use while concrete is being placed, the Contractor shall have on hand one (1) spare vibrator in serviceable condition. No concrete shall be placed until it has been ascertained that all vibrating equipment, including spares, is in serviceable condition.

Special care shall be taken to place the concrete solidly against the forms so as to leave no voids. Every precaution shall be taken to make all concrete solid, compact and smooth, and if for any reason the surfaces or interiors have voids or are in any way defective, such concrete shall be repaired as directed by the Engineer. No defective work shall be patched or repaired without the prior inspection and approval of the Engineer.

N. The temperature of concrete when it is being placed shall be not more than 90 degrees F. nor less than 40 degrees F. in moderate weather, and not less than 50 degrees F. in weather during which the mean daily temperature drops below 40 degrees F. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F., the Contractor shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The Contractor shall be entitled to no additional compensation on account of the foregoing requirements.

O. Concrete shall not be placed on a frozen subgrade or subgrade that contains frozen materials. All ice and snow shall be removed from inside forms and from reinforcing steel and embedded items. The temperature of all surfaces that the concrete will contact shall be raised above the freezing point for at least 12-hours prior to placing new concrete.

The minimum temperature of fresh concrete as mixed shall be 60 degrees F. for ambient temperature above 30 degrees F.; 65 degrees F. for ambient temperature 0 degrees F. to 30 degrees F.; and 70 degrees F. for ambient temperature below 0 degrees F. The minimum temperature of fresh concrete after placing shall be 55 degrees F. for the first 72-hours.

The use of calcium chloride shall not be permitted.

In general, the Contractor shall adhere to the recommendations as outlined in ACI Standard 306 for cold weather concreting, except as required herein.

3.9 REMOVAL OF FORMS

A. Do not remove forms before the concrete has attained a strength of at least 70% of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces, nor before reaching the following number of day-degrees of curing (whichever is the longer):

TABLE 4

Forms for	Degree Days
Elevated beams and elevated slabs	500
Walls and vertical surfaces	100
Foundation footings and slabs-on-grade	100

(See definition of degree-days in Paragraph 3.8D)

B. Do not remove shores until the concrete has attained at least 70 percent of its specified design strength and also sufficient strength to support safely its own weight and the construction live loads upon it.

C. In cold weather, when temperature of concrete exceeds ambient air temperature by 20 Degrees F at the end of the protection period, loosen forms and leave in place for at least 24 hours to allow concrete to cool gradually to ambient air temperature.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities. Fill tie holes and depressions and bug-holes ¼ inch or larger in width or depth with mortar.

1. Apply to concrete surfaces to be covered by backfill or coated with below grade waterproofing systems.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces in water channels, below water surface of basins, inside meter and valve vaults, inside cells of hydraulic splitter boxes and weirs.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
4. Formed concrete surfaces inside buildings and machine rooms and all exposed exterior surfaces of foundations, basins, vaults, hydraulic structures and curbs.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture. Surface irregularities shall not exceed ¼ inch.

1. Apply float finish to surfaces indicated and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or floor slabs to be covered with grouted tile or topping grout and slabs to be covered with built-up roofing.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces all building and machine room floors, basin floors not receiving a grout topping, channel floors, top of interior walls, top of interior curbs, steps and walkways.
2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to exterior walkways, curb, gutter, sidewalk and steps, top of valve or meter vaults, electrical pull boxes and catch basins. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. The schedule for finished unformed surfaces shall be as follows:

Unformed Concrete Surface Schedule

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material.	Scratch Finish
Floor slabs to be covered with grouted tile or topping grout and slabs to be covered with built-up roofing.	Float Finish
All building and machine room floors, basin floors not receiving a grout topping, channel floors, top of interior walls, top of interior curbs, steps and walkways.	Trowel Finish
Exterior walkways, curb, gutter, sidewalk and steps, top of valve or meter vaults, electrical pull boxes and catch basins.	Fine-Broom Finish

3.12 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

D. Immediately following the first frost in the fall, the Contractor shall be prepared to protect all concrete against freezing.

3.13 CONCRETE SURFACE REPAIRS

A. It is the intent of these Specifications to require quality work including forming, mixture and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.

B. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

C. As soon as the forms have been stripped and the concrete surfaces exposed: Remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

D. Immediately after removal of forms remove tie cones and metal portions of ties. Fill holes promptly upon stripping as follows: Moisten the hole with water, roughen first if necessary for adhesion, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.

E. When filling tie cone holes and patching or repairing exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color to match by addition of white cement. Rub lightly with a fine carborundum stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Do not damage or stain the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

F. Defective concrete and honeycombed areas: Chip down square and at least 1-in deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8-in wide all around the steel. For areas less than 1-1/2-in deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2-in layers on successive days, each layer being applied (with slurry, etc.) as described above.

G. For very heavy (generally formed) patches, the Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows:

Material	Volumes	Weights
Cement	1.0	1.0
Sand	1.0	1.0
Pea Gravel	1.5	1.5

H. The Contractor may use a pre-packaged patching compound, such as: Poly-Patch by Euclid Chemical Company; Emaco R310 by BASF Chemical Company; Sikatop 122 Plus by Sika Chemical Corporation or equal only if approved by the Engineer for use and for color match.

3.14 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work. The right of the Engineer to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve the Contractor from meeting the requirements of these Specifications.

C. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes with non-shrink grout as specified in Section 03600. The work of cutting, testing and repairing the cores will be at the expense of the Contractor if defective work is uncovered. If no defective work is found, such cost will be at the expense of the Owner.

3.11 FAILURE TO MEET REQUIREMENTS

A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Section 2.8, the Engineer may require changes

inproportions or materials, or both, to apply to the remainder of the work. Furthermore, the Engineer may require additional curing on those portions of the structure represented by the test specimens which fall below the values given in Section 2.8. The cost of such additional curing shall be at no additional cost to the Owner. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner. In such cases of failure to meet strength requirements the Contractor and Owner shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in C94 is the Contractor.

B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In cases where tests of cores fall below the values given in Section 2.8, the Engineer, in addition to other recourses, may require load tests on any one of the slabs, walls, beams, and columns in which such concrete was used. Test need not be made until concrete has aged 60 days. The Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. All coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner.

C. Should the strength of test cylinders fall below 60 percent of the required minimum 28 day strength, the concrete shall be immediately rejected and shall be removed and replaced at no additional cost to the Owner.

END OF SECTION 033000

SECTION 034100 -PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes precast structural concrete.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each precast concrete mixture.

C. Shop Drawings:

1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.

D. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Welding certificates.

C. Material certificates.

D. Material Test Reports: For aggregates.

E. Source quality-control reports.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated as a PCI-certified plant as follows:

a. Group C, Category C2 - Prestressed Hollowcore and Repetitively Produced Products.

B. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.5 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design precast structural concrete units.

B. Design Standards: Comply with ACI 318 and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

C. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.

D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M or ASTM A 1064/A 1064M, flat sheet.

F. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.3 PRESTRESSING TENDONS

A. Strand: ASTM A 416/A 416M, Grade 270, uncoated, seven-wire, low-relaxation strand.

1. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.7 and sheath with polypropylene tendon sheathing complying with ACI 423.7. Include anchorage devices and coupler assemblies.

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type II, gray, unless otherwise indicated.

B. Supplementary Cementitious Materials:

1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
2. Metakaolin: ASTM C 618, Class N.
3. Silica Fume: ASTM C 1240, with optional chemical and physical requirement.
4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33/C 33M. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

2.5 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C 150/C 150M, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.

B. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-

minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.

C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 116 when tested according to ASTM C 1218/C 1218M.

D. Normal-Weight Concrete Mixtures: Proportion by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): Minimum of 4000 psi or as required for structural concrete in Section 033000 (Cast In Place Concrete), whichever is greater.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water Absorption: Limit water absorption to 6 percent by weight or 14 percent by volume, tested according to ASTM C 642, except for boiling requirement.

F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.

G. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

H. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.7 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Engineer's approval.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.

H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

I. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

J. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.

K. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

L. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.

M. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

N. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Engineer's approval.

2.8 CASTING INSULATED WALL PANELS

A. Cast, screed, and consolidate wythe supported by mold.

B. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.

C. Cast, screed, and consolidate top wythe to meet required finish.

2.9 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

2.10 COMMERCIAL FINISHES

A. Commercial Grade: Remove fins and protrusions larger than 1/8 inch and fill holes larger than 1/2 inch. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to 3/16 inch.

B. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch in width that occur more than once per 2 sq. in.. Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch.

C. Grade B Finish: Fill air pockets and holes larger than 1/4 inch in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch in width that occur more than once per 2 sq. in.. Grind smooth form offsets or fins larger than 1/8 inch. Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.

D. Grade A Finish: Repair surface blemishes and fill air holes with the exception of air holes 1/16 inch in width or smaller, and form marks where the surface deviation is less than 1/16 inch. Float apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration at form joints is permitted. Grind smooth all form joints.

E. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.

F. Smooth, steel trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

G. Apply roughened surface finish according to ACI 318 to precast concrete units that receive concrete topping after installation.

2.11 SOURCE QUALITY CONTROL

A. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements and ASTM C 1610/C 1610M, ASTM C 1611/C 1611M, ASTM C 1621/C 1621M, and ASTM C 1712/C 1712M.

B. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.

1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
2. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
3. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

D. Field cutting of precast units is not permitted without approval of Engineer.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.

F. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

3.2 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Architect.

3.3 REPAIRS

A. Repair precast structural concrete units if permitted by Architect.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.

C. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect.

3.4 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100

SECTION 034110 – PRECAST DOUBLE TEES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof double tees.
   2. Accessories

1.2 RELATED REQUIREMENTS

A. Division 01 – General Requirements.

B. Section 03 3000 – Cast-in-Place Concrete.

C. Section 04 2113 – Unit Masonry.

D. Section 05 2100 – Steel Joists.

E. Section 05 5000 – Metal Fabrications.

1.3 REFERENCE STANDARDS

A. Reference the “Latest Edition” of all Standards unless noted otherwise.

B. ACI – American Concrete Institute International.

C. ACI 318 – Building Code Requirements for Structural Concrete.

D. AWS – American Welding Society.

E. ICC (IBC) – 2006 International Building Code.

F. PCI – Precast/Prestressed Concrete Institute.

G. PCI MNL-116 – Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

H. PCI MNL-135 – Tolerance Manual for Precast and Prestressed Concrete Construction.

1.4 ADMINISTRATIVE REQUIRMENTS

A. Coordination: Coordinate openings sizes and locations, attachment of related items, and other work related to the fabrication and installation of precast concrete units.

B. Sequencing: Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

C. Preinstallation Meeting: Conduct a preinstallation meeting a minimum of two weeks prior to installation of precast concrete. Require attendance of related trades and the Engineer. Review the following items:
   1. Review shop drawings and installation details.
   2. Anchor and weld plate locations.
   3. Opening locations including those cut in the field.
   4. Limitations on field cutting and core drilling.
   5. Site access requirements and obstructions including but not limited:
      a. Access roads and maintenance thereof.
      b. Protection and repair of existing paving.
      c. Dewatering of footing trenches.
      d. Job site snow removal.
      e. Job site debris removal.
      f. Overhead obstructions including power lines.
   6. Cold weather grouting requirements and expectations.
   7. Cleaning responsibilities and expectations.

1.5 PREFORMANCE REQUIREMENTS

A. Structural Performance: Provide precast concrete units and connections capable of withstanding design loads within limits and under conditions indicated on Drawings.
   1. Loading Requirements: As indicated in the drawings.
   2. Fire Resistance Ratings per 2006 International Building Code: As indicated on the drawings.

1.6 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements; submittal procedures.

B. Shop Drawings: Include layout plans with unit locations, bearing and top of unit elevations, overall dimensions, building cross sections, wall sections, details, and opening locations.
   1. Separately elevate and dimension each type of unit. Indicate location of each unit on overall layout by using the same identification mark placed on the actual unit.
   2. Indicate all cast-in openings 12 inches or larger in dimension. Label each opening as “cast-in”. Generally note all other non-cast-in openings are to be cut in the field by related trades after approval by precaster’s engineer.
   3. Indicate welded connections by AWS standard symbols and show size, length, and type of each weld.
   4. Indicate locations of and detail hardware and anchorage devices to be cast-in to precast units with relationship to structure.
   5. Indicate locations of and detail hardware and anchorage devices to be embedded into or attached to structure or other construction with relationship to structure.
   6. Schedule loose hardware and anchorage devices to be installed by others; Include in schedule: identification marks, item descriptions, and total quantities.

7. Indicate locations of and detail lifting and handling devices.
8. Indicate sections and details showing quantities and position of reinforcing steel and related items including special reinforcement.
9. Indicate shim sizes and grouting sequence.
10. Handling procedures, sequence of erection, and bracing plan.

C. Comprehensive Engineering: Signed and sealed by a professional engineer responsible for its preparation who is registered in the state in which the project is located. Include all dead, live, and other applicable loads used in the design. Indicate loading on shop drawings.

D. Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, notify the Engineer immediately and submit design calculations and drawings. Do not adversely affect the appearance, durability or strength of units when modifying details or materials. Maintain the general design concept when altering size of units and alignment.

E. Samples: Provide Owner/Engineer with samples representing the finish color and texture of exposed surfaces when requested. Samples to be a minimum of 12 by 12 by 2 inches in size. Owner/Engineer to verify finish meets or exceeds the expectation of the design intent.

F. Test Reports: At the request of the Owner/Engineer provide test reports for concrete and other structural materials tested during fabrication including cement mill reports, mix reports, cylinder break reports.

1.7 QUALITY ASSURANCE

A. Designer Qualifications: Precast concrete units to be designed under the direct supervision of a Professional Structural Engineer licensed in the state where the project resides and be directly employed by precast fabricator to assure that quality and structural integrity is being scrutinized on a daily basis.

B. Fabricator Qualifications: A firm that specializes in manufacturing the types of precast concrete specified in good standing in the PCI Plant Certification Program, and that complies with the following requirements: No Exceptions. No other plant certification will be accepted.
1. Assumes responsibility for engineering precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and Comprehensive Engineering analysis by a qualified Professional Engineer.
2. Participates in PCI's Plant Certification program at the time of bidding and through the construction process.
3. Has sufficient production capacity to produce required units without delaying the Work.
4. Is registered with and approved by authorities having jurisdiction.

C. Erector Qualifications: PCI Certified, approved by the precast concrete manufacturer, and having a minimum of 5 years experience in the erection of precast concrete similar to the requirements of this project. Erector's workman shall be properly trained to handle and erect precast units.

D. Design Standards: Comply with ACI 318 (ACI 318M) and the design recommendations of PCI MNL 120, "PCI Design Handbook – Precast and Prestressed Concrete," applicable to types of structural precast concrete units indicated.

E. Quality-Control Standard: For manufacturing procedures and testing requirements and quality control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Concrete Products."
   1. Comply with camber and dimensional tolerances of PCI MNL 135, "Tolerance Manual for Precast and Prestressed Concrete Construction."

F. Welder Qualifications: AWS Certified, approved by the precast concrete manufacturer, and having a minimum of 5 years experience in the erection of precast concrete similar to the requirements of this project. Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel"; and AWS D1.4, "Structural Welding Code – Reinforcing Steel."

G. Pollution Control Regulations: Comply with all pollution control regulations in fabricating and finishing of all products. Protection of air and ground water is the utmost importance.
   1. Capture all water runoff and filter air as necessary in the fabrication process in compliance with all state and federal pollution control agencies.

1.8 DELIVERY, STORAGE, AND HANDLING

A. General Requirement: All lifting and handling, transportation and delivery, storage and support, and erection of precast double tees to be performed by qualified personnel using methods and equipment approved by manufacturer.

B. Identification: Label each unit with date of production and mark indicating unit location on the shop drawings.

C. Lifting and Handling: Lift and handle units at all times by lifting points indicated on the shop drawings. Lift with manufacturer approved lifting devices. Lifting devices to have a minimum safety factor of 5 to 1.

D. Transportation and Delivery: Transport units in accordance with manufacturer requirements.

E. Storage and Support: At all times store and support units off ground with identification marks clearly visible and so lifting devices are accessible and undamaged. Separate stacked units by batten across full width of each bearing point. Do not use stacked precast units for storage of other units or equipment.

1.9 FIELD CONDITIONS

A. General Contractor shall prepare and maintain site free of obstructions as required by precast erector for the work of this section.

B. Cold Weather Grouting: Provide written procedures to address cold weather grouting to Owner/Engineer prior to the erection process.

1.10 WARRANTY

A. Provide twelve-month guarantee for workmanship, materials, and satisfactory performance from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Precast Concrete:
   1. Olympus Precast Bluffdale, Utah 84065
   2. Or Approved Equal
   3. Substitutions: See Section 01 6000 – Product Requirements; including the following requirements:
      a. Manufacturer and plant must be PCI Certified. No Exceptions.
      b. Manufacturer must submit product information including typical details, proposed product construction, handling information, etc. for approval by Engineer.
      c. Manufacturer must obtained written approval of General Contractor prior to submitting bid.
      d. Prequalified Precaster must have in-house engineering capabilities. No others permitted without being pequalified.
      e. Precast Erector shall be PCI Certified.

2.2 PRECAST UNITS

A. Roof Double Tees.
   1. Size/Shape/Profile: As indicated on the drawings.
   2. Screed Side: As indicated under “By Description” below.
   3. Form Sides: Grade B (PCI), refer to description below.
   4. Ends: Recess strands and coat with ZRC.
   5. Concrete Color: Gray.

B. Form Side Finishes “By PCI”:
   1. Commercial Grade (PCI): This is essentially a "as-cast" finish. Concrete may be produced in forms that impart a texture to the concrete, (e.g. plywood lumber or steel forms with offset joints, dents, or holes). The surface may contain air holes (bug holes) and water marks, and there may be some minor chips and spalls. There may be patches and streaks of color variation within the surface, and the overall color tone may vary between pieces.
      a. Large fins from joint bleeding should be removed, but small fins may remain. Only "honeycombed" and/or badly spalled areas should be repaired or finished. All faces should have true, well-defined surfaces. The maximum allowable form joint offset should be limited to 3/16 inch.
      b. This finish should be specified only when the product will not be visible in the completed structure, or when the function of the structure does not require an enhanced surface.
   2. Standard Grade (PCI): Small surface holes caused by air bubbles ("bug holes"), normal color variations, normal form joint marks and minor chips and spalls should be considered acceptable.

a. No air holes (bug holes) larger than 1/2 inch in any direction should be permitted. Air holes between 1/4 and 3/8 inch in width that occur in high concentration (more than one per 2 square feet) should be filled. Large, unsightly surface blemishes or honeycombing should be repaired. The maximum allowable form joint offset should be limited to 1/8 inch. This finish may be used where products are exposed to view but the function of the structure does not require a special finish. The surface should be suitable for an applied textured coating but not necessarily suitable for painting. This is the typical finish grade for all structural units unless noted otherwise

3. Grade B (PCI): All air holes over 1/4 inch in size should be filled. Air holes between 1/8 and 1/4 inch in width that occur in high concentration (more than one per 2 square inches) should be filled. Surface blemishes due to holes or dents in form should be repaired. Discoloration should be permitted at form joints.
4. Grade A (PCI): In addition to the requirements for Grade B, all exposed surfaces shall be coated with a neat cement paste. After paste coat has dried the surface shall be rubbed with burlap to remove loose particles.

C. Screed Side Finishes "By Description":
1. Top of Double Tee Roof Panel: Screed to true surfaces free from high and low areas and then float to a relatively smooth surfaces free from projecting gravel, footprints, or other defects to provide a finish suitable for application of fully adhered TPO Membrane roofing system.

2.3 MATERIALS

A. All materials shall comply with the specifications, standards and codes quoted herein. The Engineer upon request shall be furnished satisfactory certification that all material incorporated in the precast concrete products comply with the requirements herein specified.

B. Forms: Material that will provide smooth/anticipated finish that meets the expectations of the Owner/Engineer.

C. Form Release Agent: Non-staining type that will not impair anticipated finishes of the Owner/Engineer and that will not inhibit field installed coatings, sealants, and adhesives.

D. Portland Cement: ASTM C150 - Type I or III: ASTM C150.

E. Other Cementitious Materials: Ground granulated blast furnace slag: ASTM C 989.

F. Admixtures:
1. Air entraining admixtures: ASTM C260.
2. Water reducing, retarding, accelerating admixtures: ASTM C494.

G. Aggregates: ASTM C33 except that coarse aggregates for precast concrete surfaces exposed to damp conditions shall contain zero iron oxides.
1. Light weight aggregate for structural components: ASTM C330.

H. Water: Potable or free from foreign materials in amounts harmful to concrete and embedded steel.

I. Reinforcing Steel: Reinforcing steel or mesh will be selected from the following materials to conform to precaster's design unless otherwise indicated on the drawings. Reinforcing bars shall not be welded without specific approval of Engineer.
   1. Bars:
      a. Deformed billet steel: ASTM A615.
      b. Deformed rail steel: ASTM A616.
      c. Deformed axle steel: ASTM A617.
      d. Deformed low-alloy steel: ASTM A706.
   2. Wire: Cold drawn steel: ASTM A82.
   3. Wire fabric:
      a. Welded steel: ASTM A 185.
      b. Welded deformed steel: ASTM A497.

J. Strand: Uncoated, 7-wire, Stress-Relieved Strand: ASTM A416-Grade 250K or 270K.

K. Anchors and Inserts:
   1. Materials:
      a. Structural Steel: ASTM A36.
         1) Shop Primer: Manufacturer's standards.
            a) Location: Items protected by sealants or finish coatings.
         2) Hot Dipped Galvanized: ASTM A153.
            a) Location: Items left exposed unless otherwise indicated. Cold galvanize field welds.
         3) Zinc-rich Coating: MIL-P-2135, self curing, one component, sacrificial.
            a) Location: As indicated.
         4) Cadmium Coating (Electroplated).
            a) Location: As indicated.
      b. Stainless Steel: ASTM A666, type 304.
         1) Location: As indicated.

L. Other Items Cast-In to Precast Units:
   1. Other Items: As indicated on the drawings.
   2. Locations: As indicated on the drawings.

2.4 ACCESSORIES

A. Cement Grout: Type I (ASTM C150 / C150M), "Dry Pack", portland cement, sand and water having a minimum of 3,000 psi compressive strength at 28 days. (Approximately 3 to 1 sand/cement ratio.)

B. Bearing Pads:
   1. Unless noted otherwise on the plans, Elastomeric Bearing Pads conforming to Division 2, Section 25 of AASHTO Standard Specifications for Highway Bridges shall be used.
   2. The PCI Design Handbook, Second Edition, Part 5.1 through Part 5.5 shall be used for the design of bearing pads.
   3. Teraflouroethylene (TFE) reinforced with glass fibers and applied to stainless or structural steel plates.

C. Sealants:

1. Refer to Section 07 9200 - Joint Sealants; Precast to precast products.
2. Tremco; Dymeric 240 FC: www.tremcosealants.com.
3. BASF Sonneborn; Sonolastic NP2: www.buildingsystems.basf.com.
4. Backer Rod: Denver Foam or equivalent. www.backerrod.com.
5. Provide products compatible with adjacent work.

D. Backer Rod for Sealants: Denver Foam by www.backerrod.com, open cell polyurethane, unless noted otherwise.

E. Galvanized Sheet Materials: Per ASTM A 653/A 653M; G90 zinc coating.

F. Welding Materials: Per AWS D1.1/D1.1M, “Structural Welding Code – Steel”; compatible with materials being welded.

G. Welded Studs: Per AWS D1.1/D1.1M, “Structural Welding Code – Steel”; compatible with materials being welded.

H. Pipe Sleeves:
1. 3/4” Conduit or PVC pipe.
2. Location to be 4'-0" to 6'-0" on center, verify layout with electrical engineer.
   a. Start 2'-6" in from outside walls.
   b. Install in each roof and mezzanine double tee leg at 5'-0" on center.
   c. Spacing shall be uniform and consistent throughout.
   d. Unused pipe sleeves to be sealed by others.
3. Pipe sleeves to be capped.

I. Anchor Bolts: As designed by precast manufacturer, cast-in place by others.

J. Attachment Plates: As designed by precast manufacturer, cast-in place by others.

K. Other Load Bearing Loose Steel Items: As designed by precast manufacturer.

2.5 FABRICATION

A. Double Tee Camber as designed by precaster in accordance with design loads.

B. Pre-stress all precast units.

C. All reinforcing steel shall have minimum cover as required by code and shall be accurately located as indicated on the approved shop drawings. Metal chairs, with or without coatings, shall not be permitted in the finished face.

D. All of the fabrication procedures shall be carried out under a fully protective overhead and sidewall covering, with a constant temperature of between 50 to 80 F being maintained except during the curing cycle.

2.6 FABRICATION TOLERANCES

A. Fabricate units in accordance with MNL-116 and MNL 135-00 and as follows:
   1. Length: Plus or minus 1/8 inch for every 10 feet in length or 1/2 inch, whichever is greater.
   2. Width: Plus or minus 1/8 inch for items 48 inch or less; 1/4 inch for items 48 to 120 inches, and 1/2 inches maximum for items over 120 inches and more.
   3. Cross Sectional Dimensions: Plus or minus 1/8 inch for items 48 inch or less; 1/4 inch for items 48 to 120 inches, and 1/2 inches maximum for items over 120 inches and more.
   4. Cast-in Anchors and Inserts: Plus or minus 1 inch from centerline location indicated on shop drawings.
   5. Horizontal Alignment (Sweep): Plus or minus 1/3 inch for every 10 feet in length or 1/2 inch, whichever is greater.
   6. Vertical Alignment (End Squareness): Plus or minus 1/8 inch for every 12 inches in height or 1/4 inch, whichever is greater.
   7. Camber: Variation between units is plus or minus 1/4 inch for every 10 feet in length or 1/2 inch, whichever is greater.
   8. Blockouts: Plus or minus 1 inch from centerline location indicated on shop drawings.

2.7 CONCRETE MIXES

A. 28-day compressive strength: Minimum of 5,000 psi.

B. Use of calcium chloride, chloride ions or other salts is not permitted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify site is free of obstructions and ready to receive the work. Obstructions include but are not limited to dewatering of footing trenches, jobsite snow removal, site debris, overhead obstructions, including power lines.

B. Verify access roads have been prepared to handle all weather conditions and are acceptable to precast concrete installer.

C. Do not begin the work of this section unless preparations by the site contractor are complete and the site contractor understands and agrees to maintain acceptable conditions until precast installation is complete. Beginning the work of this section is acceptance of existing conditions.

3.2 PREPARATION

A. Preparation: General Contractor shall be responsible for the following items:
   1. Removal of all obstructions including but not limited to power lines and wires that may be hazardous to precaster’s personnel and other items required for precast installation.
   2. All-weather access roads for precaster's trucks and cranes. Refer to precaster's proposal/quotation for more defined access requirements.
   3. Grid locations, building corners, finish floor elevations, top of door elevations and other survey points/lines/elevations for accurate installation of precast units.

4. True and level bearing surfaces on all field placed bearing walls and other field placed supporting units.
5. Placement and accurate alignment of anchor bolts, plates, or dowels in column footings, grade beams, and other field placed supporting units.
6. All shoring required for composite beams and slabs. Shoring shall have a minimum load factor of 1.5 x (dead load plus construction loads).
7. Repair all concrete and bituminous surfaces damaged during precast installation. Examine surfaces with precaster before and after precast installation and coordinate efforts to minimize damage.
8. Requirements For long span DTs - No shipping of long span units shall occur during road postings. Precaster's crane and trucks will erect from the interior side of the building at area's requiring long span units. Provide 50' wide access into the building and a clear erection area of 50' wide. Trucks and cranes will operate under their own power. Maximum grade on which erection will occur to be 4 percent. Haul roads to be approximately level transverse and 14 percent maximum longitudinal grade.

3.3 ERECTION

A. Precast installer shall be PCI Certified Erector in good standing with PCI.

B. Precast Unit Curing Procedures: Contact precaster for other minimum curing requirements.

C. Erection Shall Be Defined As:
1. Placing, aligning, and leveling the precast units in final positions in the structure on the designated supporting surfaces.
2. Connection of precast units to each other, or to supporting structural units as indicated on the shop drawings.
3. Removal of lifting hooks, if necessary.
4. Cleaning and sealing of "Precast" to "Precast" joints. Joints include:
    a. Precast to precast including joints between interior and exterior units.
    b. Precast to bearing.
5. Sealing of "Precast" to "Other Materials" and joints that require "Firestopping" are NOT considered part of erection unless indicated otherwise.

D. Joints Between Roof Double Tees:
1. If the space between flanges of adjacent roof tees exceeds 3/4 inch, it shall be covered with a minimum 3 inch wide continuous 20 gauge galvanized sheet metal cover adhered on each side with plastic flashing cement. Cement shall not run into joints.

E. Field Welding: Complete field welding using qualified personnel, equipment, and welding materials that are compatible to the base material.

F. Patching:
1. All exposed connections shall be recessed and patched as per the intended use of the space these are exposed to.

3.4 TOLERANCES

A. Erect precast units level, plumb, square, true, and in alignment without exceeding the non-cumulative erection tolerances of PCI MNL 135. Position units so that dimensional errors do not accumulate and so joints remain aligned and uniform as erection progresses. Level out variations between adjacent units by jacking, loading, or any other feasible method as recommended by the manufacturer and acceptable to the Engineer.

B. In the event that precast units cannot be adjusted to conform to design or tolerance criteria, cease work and advise Engineer. Execute modifications as directed by the Engineer prior to resuming work.

3.5 SEALANT INSTALLATION

A. General Contractor/Owner shall coordinate with the precast erector sealing of precast joints where required. The general contractor accepts responsibility if the precast joints above the roof deck and below grade are not sealed due to poor coordination/site conditions. The precast erector shall accept responsibility if precast joints are not sealed but were coordinated in a timely fashion by the General Contractor/Owner.

B. Install backer rod and sealant according to product manufacturer’s instructions.

3.6 FIELD REPAIR AND CLEANING OF PRECAST UNITS

A. Repairs by Precast Erector: Repair chipping, spalling, cracking, and other damages to precast units after delivery to the jobsite. After installation and repairs are completed, all further damage is the responsibility of, and at the cost of, the General Contractor. Consult with precaster for repairs of structural precast units.

B. Cleaning by General Contractor: Clean exposed surfaces that are soiled during shipping, installation, and remaining construction operations, prior to Substantial Completion. Clean in accordance with precast manufacturer’s recommendations.

3.7 INSPECTION AND ACCEPTANCE

A. Final inspection and acceptance of erected precast/prestressed concrete shall be made by Engineer to verify conformance with plans and specifications.

3.8 PROTECTION

A. General Contractor to protect precast units from remaining construction operations.

END OF SECTION 034110

SECTION 036000 – GROUTING MORTAR

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, place, finish and cure the following types of grouting mortars as called for herein and as shown in the Contract Documents

B. Perform all sampling and furnish all testing of materials and products by an independent testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor

1. Non-Shrink Grout: This type of grout shall be used wherever grout is shown or called for in the Contract Documents, unless another type is specifically referenced.

2. Topping Grout: This type of grout shall be used for grouting clarifier bottoms.

3. Epoxy Grout: This type of grout shall be used for anchor bolt or reinforcing steel embedment, repairs and resurfacing.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-In-Place Concrete. 033000

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Specifications, codes and standards is listed under Section 033000 entitled, "Cast-In-Place Concrete", and those additional commercial standards as follows:

CRD-C 621-85	Corps of Engineers Specification for Non-Shrink Grout
ASTM C 109	Standard Test Method for Compressive (Latest Edition) Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens)
ASTM C-827-87	Standard Test Method for Early Volume Change of Cementitious Mixtures
ASTM C150	Standard Specification for Portland Cement
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concrete.

ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concrete.
ASTM C1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM E329	Standard specification for agencies engages in the testing and/or inspection of materials used in construction

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 CONTRACTOR SUBMITTALS

A. Non-Shrink Grout: Submit manufacturer's catalogue cuts, technical data including compressive strength and expansion data at plastic, flowable and fluid consistencies, storage requirements, product life, working time after mixing, temperature consideration, conformity to the specified ASTM standards, and Material Safety Data Sheets. Also submit manufacturer's applications manual containing instructions and recommendations for mixing, handling, placement and appropriate uses for each type of non-shrink grout used in the work.

B. Topping Grout: Provide certified mix design including type and brand of cement, proportions and gradations of all materials, product data on any proposed admixtures, and compressive strength test results from at least one (1) trial batch. Tests shall be performed by a certified testing laboratory. All costs for such mix design and trial batch tests shall be borne by the Contractor.

C. Non-shrink Epoxy Grout: Submit manufacturer's catalog cuts, technical data including strengths and application manual of instructions for mixing, handling and placing, storage requirements, product life, working time after mixing, temperature consideration, conformity to the specified ASTM standards, and Material Safety Data Sheets.

1.5 QUALITY ASSURANCE

A. Qualifications

1. Grout manufacturers shall have a minimum of 10 years experience in the production and use of the type of grout proposed.

2. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in

which the Contractor or officers of the Contractor's organization have beneficial interest are not acceptable.

B. Pre-installation Meeting

1. At least ten working days before grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Notify all parties involved with grouting, including the Engineer, of the meeting at least ten working days prior to its scheduled date.

C. Services of Manufacturer's Representative

1. Provide services of a field technician of the non-shrink grout manufacturer who has performed at least five projects of similar size and complexity during the last five years, to attend the pre-installation meeting, to be present for the initial installation of each type of non-shrink grout, and to correct installation problems.

D. Field Testing

1. All field testing and inspection services will be provided by the Owner. Assist in the sampling of materials, and cooperate by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Methods of testing will comply with the applicable ASTM Standards.

2. Field testing of concrete grout will be as specified for concrete in Section 03300.

3. Mix design tests for topping grout shall be performed per the standards referenced herein.

E. During the progress of construction the Engineer may have tests made of each type of grout used in the work to ensure compliance with the Contract Documents. These tests will be made in accordance with the standards referenced herein. The test expense during construction, except for the mix design and trial batch tests, will be borne by the Owner. The costs of additional tests including non-destructive tests and core drilling needed to verify or investigate the quality of questionable work or material shall be borne by the Contractor.

F. Grout for testing shall be supplied by the Contractor at no cost to the Owner.

G. If any grout fails to meet the requirements of these specifications, immediate corrective action shall be taken for all subsequent batches. Grout already in place which fails to meet these requirements is subject to removal and replacement with all costs borne by the Contractor.

H. Construction tolerances shall be as specified in Section 033000 entitled, "Cast-In-Place Concrete", except as modified herein and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.1 NON-SHRINK GROUT

A. Non-shrink grout shall be a prepackaged, inorganic, non-gasliberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged.

B. Non-shrink grouts for use as herein specified shall conform to the Corps of Engineers specifications for Non-Shrink Grout, CRD-C621-85 and to these specifications. The grout shall have a 28-day compressive strength of 6,000 psi or greater.

C. Non-shrink grouts shall be as manufactured by: Tremcrete Systems Incorporated, Woodland, California; Gifford-Hill & Company, Inc., Dallas, Texas; or approved equal.

2.2 TOPPING GROUT

A. Cement topping grout for clarifiers or channels shall be composed of one part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. The minimum compressive strength at 28-days shall be 4,000 psi.

B. Cement grout materials shall be as specified in Section 033000 entitled, "Cast-In-Place Concrete".

2.3 EPOXY GROUT

A. Epoxy grout shall be a pourable, non-shrink, one-hundred percent (100%) solids system. The epoxy grout system shall have three components; resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

B. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F. The epoxy grout shall develop a minimum compressive strength of 5,000 psi in 24-hours and 10,000 psi in 7-days.

2.4 CURING MATERIALS

A. Curing materials shall be as specified in Section 033000 entitled, "Cast-In-Place Concrete", for cement topping grout and as recommended by the manufacturer of non-shrink grouts.

PART 3 - EXECUTION

3.1 PLACING NON-SHRINK AND EPOXY GROUT

A. All forming, mixing, surface preparation, handling, placing and consolidated of non-shrink and epoxy grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Curing shall be as specified herein.

END OF SECTION 036000

SECTION 037400 PRESSURE INJECTION OF CRACKS

PART 1 – GENERAL

1.1 DESCRIPTIONS

A. This section covers the repair of cracks in concrete by the injection of an epoxy resin adhesive.

1.2 REFERENCE STANDARDS

A. The publications listed below form part of this specification to the extent referenced and are referred to in the text by the basic designation only. Reference shall be made to the latest edition of said standards unless otherwise called for.

ASTM D695 - Test method for Compressive Properties of Rigid Plastics

1.3 REPAIR CRITERIA

A. Cracks in concrete at least 0.02 inches in size shall be repaired.

1.4 QUALIFICATIONS

A. Epoxy injection shall be performed by a certified applicator.

B. Contractor's operator engaged in the epoxy injection process shall have satisfactory operator experience in the methods of restoring concrete structures utilizing the specific epoxy injection process indicated. Operator's experience shall include previous repairs of cracked or damaged concrete structures, the technical knowledge of correct material selection and use, and the operation, maintenance and trouble shooting of equipment.

PART 2 – PRODUCTS

2.1 EPOXY RESIN ADHESIVE FOR INJECTION

A. Epoxy adhesive grout shall be a 100 percent solids 2-part water insensitive low-viscosity epoxy resin system. Epoxy shall be suitable for grouting both dry and damp cracks. Epoxy shall develop a minimum tensile strength (ASTM D695) of 6,000 psi and a minimum compressive strength of 8,000 psi. Epoxy shall be Sikadur 35, Hi-Mod LV by Sika Corporation, or equivalent.

2.2 SURFACE SEAL

A. The surface seal material is that material used to confine the injection adhesive in the fissure during injection and cure.

B. The surface seal material shall have adequate strength to hold injection fittings firmly in place and to resist injection pressures adequately to prevent leakage during injection.

C. The material shall be from the same manufacturer of the epoxy resin adhesive and be of a compatible material.

2.3 EQUIPMENT FOR INJECTION

A. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the crack shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall be electric or air powered and shall provide in-line metering and mixing.

B. The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi plus or minus 5 psi and shall be equipped with a manual pressure control override.

C. The injection equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 200 psi.

PART 3 – EXECUTION

3.1 PREPARATION

A. Surface adjacent to cracks or other areas of application shall be cleaned of dirt, dust, grease, oil, efflorescence or other foreign matter which may be detrimental to the integrity of the bond between the epoxy and the injection surface. Acids and corrosives shall not be permitted.

B. Grind surface application area to expose aggregate.

C. Entry ports shall be provided along the crack at intervals of not more than the thickness of the concrete being repaired. Ports shall be compatible with pressure injection equipment.

D. Surface seal material shall be applied to the face of the crack between the entry ports. For through cracks, surface seal shall be applied to both faces.

E. Enough time for the surface seal material to gain adequate strength shall pass before proceeding with the injection.

3.2 EPOXY INJECTION

A. Injection of epoxy adhesive shall begin at lower entry port and continue until there is an appearance of epoxy adhesive at the next entry port adjacent to the entry port being pumped.

B. When epoxy adhesive travel is indicated by appearance at the next adjacent port, injection shall be discontinued on the entry port being pumped, and epoxy injection shall be transferred to the next adjacent port where epoxy adhesive has appeared.

C. Epoxy adhesive injection shall be performed continuously until cracks are completely filled.

D. If port to port travel of epoxy adhesive is not indicated, the work shall immediately be stopped and the Engineer notified.

3.3 FINISHING

A. When cracks are completely filled, epoxy adhesive shall be cured to sufficient time to allow removal of surface seal without any draining or runback of epoxy material from cracks.

B. Surface seal material and injection adhesive runs or spills shall be removed from concrete surfaces.

C. The face of the crack shall be finished flush to the adjacent concrete showing no indentations or protrusions caused by the placement of entry ports.

3.4 PRESSURE TEST

A. The mixing head of the injection equipment shall be connected and the equipment run until clear uniformly mixed material flows into the purge pail. The operator shall engage the equipment shut-off nozzle valve and subsequently bump the on-off switch while monitoring pressure on psi gauge until the pressure reaches 200 psi. Pressure gauge shall be monitored for one minute. If pressure is maintained between 190-200 psi, check valves shall be considered to be functioning properly and the injection may proceed. If pressure drops below 190 psi, Contractor shall be required to have new seals installed on the check valves and the equipment shall be subsequently retested.

B. The pressure test shall be run for each injection unit at the beginning and after meal break of every shift that the unit is used in the work of crack repair.

C. The adequacy and accuracy of the equipment shall be solely the responsibility of the Contractor.

3.5 RATIO TEST

A. The epoxy mixture ratio shall be monitored continuously while injecting by placing a strip of masking tape on the sides of the A and B reservoirs full height. After filling reservoirs, the A and B levels shall be marked and monitored while running injection machine into purge pail for a period of one minute.

B. The ratio test shall be run for each injection unit at the beginning and after meal break of every shift that the unit is used in the work of crack repair.

3.6 PROOF OF RATION AND PRESSURE TEST

A. At all times during the course of the work the Contractor shall keep complete and accurate records available to the Engineer of the pressure and ratio tests specified above.

B. In addition, the Engineer at any time without prior notification of the Contractor, may request the Contractor to conduct the tests specified above in the presence of the Engineer.

END OF SECTION 037400

SECTION 051200 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Grout.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication of structural-steel components. Shop and Erection Drawings: The shop drawings shall provide a material and specification list, construction and fabrication details, layout and erect diagrams, and the method of anchorage to adjacent construction. The shop drawings shall give the location, type, size and extend of welding and bolted connections, and clearly distinguish between shop and field connections. The drawings shall be stamped by a licensed engineer. Before submittal of the shop drawings, the Contractor shall coordinate the shop drawings and related trades to ensure proper mating of assemblies. All work shall conform to the approved shop drawings.

C. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, as given in the Specifications and Drawings, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Qualification Data: For Installer.

E. Welding certificates.

F. Certified mill test reports for structural steel, including chemical and physical properties and bolting materials.

G. Source quality-control reports.

H. Field quality-control reports.

I. Documentation of certification of the steel fabricator under the AISC Quality Certification Program.

1.4 REFERENCE STANDARDS

A. American Institute of Steel Construction (AISC)

1. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges

2. AISC 316 - Manual of Steel Construction – 13th Edition

3. AISC 335 - Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design with Commentary, including ASD Supplement No. 1 (dated Dec 17, 2001)

4. AISC 348 - Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts (prepared by the Research Council on Structural Connections) B.

B . American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel

2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. ASTM A123 - Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products

4. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

5. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

6. ASTM A490 - Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength

7. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

8. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coating

9. ASTM A992 - Standard Specification for Structural Shapes

10. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

11. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield-Strength

C. American Welding Society (AWS)

1. AWS A2.4 - Standard Symbols for Welding, Brazing and Non-destructive Examination

2. AWS A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding

3. AWS D1.1 - Structural Welding Code - Steel

D. Code of Federal Regulations (CFR)

1. 29 CFR - Part 1926 Subpart R - Steel Erection

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply, unless otherwise noted.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with applicable provisions of the following specifications and documents:

1. AISC 303 – Code of Standard Practice for Steel Buildings and Bridges.
2. AISC 316 – Manual of Steel Construction – latest edition
3. AISC 360 – Specification for Structural Steel Buildings.
4. AISC 348 - RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials promptly so as to cause no delay with other parts of the work.

B. Store materials on skids and not on the ground. Pile and block materials so that they will not become bent or otherwise damaged.

C. Handle materials with cranes or derricks as far as practicable. Do not dump steel off cars or trucks nor handle in any other manner likely to cause damage.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using AISC 360.

B. Moment Connections: Type PR, partially restrained.

C. Construction: Combined system of moment frame and braced frame.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M.

B. Channels, Angles-Shapes: ASTM A 36/A 36M.

C. Plate and Bar: ASTM A 36/A 36M.

D. Square or Rectangular Hollow Structural Sections: ASTM A 500/A 500M, Grade B.

E. Steel Pipe: ASTM A 53/A 53M, or Type S, Grade B.

F. Welding Electrodes: Comply with AWS requirements, E70XX.

2.3 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.

C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating.
2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain.

E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

F. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable.

1. Configuration: Hooked.
2. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

G. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.

1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

H. Threaded Rods: ASTM A 36/A 36M.

1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

2.4 PRIMER

A. Primer: Comply with Section 098000, “Protective Coatings.”

2.5 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.8 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits.

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M.

D. Prepare test and inspection reports and submit to the Engineer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Baseplates Bearing Plates and Leveling Plates: Clean concrete bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

D. Furnish and install temporary bracing to provide stability during erection and to prevent distortion or damage to the framing due to wind, seismic, or erection forces. Remove temporary bracing when erection is complete.

E. After erection and field testing of connections, prime paint abrasions, field welds, and unprimed surfaces using shop primer, except surfaces designated to be unpainted or surfaces in contact with concrete.

F. After erection and field testing of connections, repair damaged galvanizing and prime paint abrasions and field welds at galvanized surfaces with surface primer containing zinc dust in accordance with ASTM A780. Provide a dry film thickness not less than 6 mils.

3.3 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Allow the Construction Manager free access to the work. Notify the Construction Manager in writing 4 working days in advance of high strength bolting and field welding operations, including pre-installation verification of high strength bolt assemblies.

C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M. Comply with all requests of inspectors to correct deficiencies.

E. The fact that steel work has been accepted at the shop and mill will not prevent its final rejection at the site, before or after erection, if it is found to be defective.

F. Remove rejected steel work from the site within 10 working days after notification of rejection.

END OF SECTION 051200

SECTION 051400 – STRUCTURAL ALUMINUM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for providing structural aluminum products, including sheet, pipe, extrusions, and associated accessories.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
2. B 221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
3. B 308/ B 308M – Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Shapes.

B. American Welding Society (AWS):
1. A 5.10 – Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
2. D 1.2 – Structural Welding Code- Aluminum.

1.3 SUBMITTALS

A. Quality Control Submittals:

1. Shop Drawings and Erection Drawings: Shop drawings shall be provided for all structural aluminum. The shop drawings shall provide a material and specification list, construction and fabrication details, layout and erection diagrams, and the method of anchorage to adjacent construction. The shop drawings shall give the location, type, size and extent of welding and bolted connections, and clearly distinguish between shop and field connections. Before submittal of the shop drawings, the Contractor shall coordinate the shop drawings and related trades to ensure proper mating of assemblies. All work shall conform to the approved shop drawings.
2. Shop Drawings: Include plans, sections, details and attachments to other work.
3. Delegated-Design Submittal: Where noted on the Drawings as a deferred submittal with delegated design, the structural aluminum member and system design shall be performed and sealed by a professional engineer in the State of California.
4. For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Perform welding of structural metals with welders who have current American Welding Society (AWS) certificate for the type of welding to be performed.
   2. Notify the engineer 24 hour minimum before starting shop or field welding.
   3. Engineer may check materials, equipment, and qualifications of welders.
   4. Remove welders performing unsatisfactory work, or require to re-qualify.
   5. Engineer may use gamma ray, magnetic particle, dye penetrant, or other aids to visual inspection to examine any part of welds or all welds.
   6. Contractor shall bear costs of retests on defective welds.
   7. Contractor shall also bear costs in connection with qualifying welders.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Sheet Aluminum: ASTM B 209, Alloy 6061-T06
B. Structural Aluminum: ASTM B 308 Alloy 6061-T6
C. Extruded Aluminum: ASTM B 221, Alloy 6063-T42
D. Miscellaneous Materials:
   1. Furnish supplementary parts necessary to complete each item even where such work is neither definitely indicated on the Drawings nor specified.
   2. Size, form, attachment, and location shall conform to the best of current practice.
   3. Conform to applicable ASTM Standards for materials not otherwise specified.

2.2 FABRICATION

A. Aluminum Layout:
   1. Center punch hole centers, and punch or scribe cutoff lines, except where marks would remain on fabricated material.
   2. Apply temperature correction where necessary in layout of critical dimensions. Use a coefficient of expansion of 0.00013 per degree of Fahrenheit.

B. Cutting Aluminum:
   1. Material ½ inch thick or less: Shear, saw, or cut with a router.
   2. Material more than ½ inch thick: Saw or rout.
   3. Make cut edges true and smooth, free from excessive burrs or ragged breaks.
   4. Avoid reentrant cuts wherever possible. Where used, fillet by drilling prior to cutting.
   5. Do not flame cut aluminum alloys.
   6. Punch or drill rivet or bolt holes to finished size before assembly.
      a. Make finished diameter of holes for bolts 1/16 maximum larger than nominal bolt diameter.
      b. Make holes cylindrical and perpendicular to principal surface.
      c. Do not permit holes to drift in a manner to distort metal.

C. Aluminum Forming and Assembly:
   1. Do not heat structural aluminum, except as follows:

a. Heat aluminum to 400 degrees Fahrenheit for 30 minutes maximum, to facilitate bending or welding.
b. Heat only when proper temperature controls and supervision can ensure that limitations on temperature and time are observed.

D. Before assembly, remove chips lodged between contacting surfaces.

E. Welding Aluminum:
1. Perform welding of aluminum in accordance with AWS D1.2, Structural Welding Code-Aluminum.
2. Weld aluminum in accordance with the following:
a. Preparation:
1) Remove dirt, grease, forming or machining lubricants, and organic materials, from areas to be welded by cleaning with a suitable solvent or by vapor degreasing.
2) Additionally, etch or scratch brush to remove oxide coating just prior to welding when inert gas tungsten arc welding method is used.
3) Oxide coating may not need to be removed if welding is performed by automatic or semi-automatic inert gas shielded metal arc.
4) Suitably prepare edges to assure 100 percent penetration in butt welds by sawing, chipping, machining, or shearing. Do not cut with oxygen.
b. Filler Metal: Aluminum alloys conforming to the requirements of AWS A5. 10 and AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 556.
c. Perform welding of structures which are to be anodized using filer alloys which will not discolor. When anodized, AWS ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
d. Perform welding by using a non-consumable tungsten electrode with filler material in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG).
e. Do not use welding processes that require use of a welding flux.
f. Neatly make welded closures.
g. Where weld material interferes with fit or is unsightly in appearance, grind it smooth.
h. Make welds full penetration welds unless otherwise indicated on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.2 INSTALLATION

A. Install structural aluminum products as indicated on the Drawings and specified.

B. Install structural aluminum products accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.

C. Do not cock out of alignment, redrill, reshape, or force fit fabricated items.

D. Place anchor bolts or other anchoring devices accurately and make surfaces which bear against structural items smooth and true to level. Unless noted otherwise all anchor bolts shall be 304 stainless steel.

E. Rigidly support and brace structural products needing special alignment to preserve straight, level, even, smooth lines, and keep braced until concrete, grout, or dry pack mortar has hardened for a minimum 48-hour period.

F. Interface with Other products - See specification section 098000.

END OF SECTION

SECTION 052100 – STEEL JOISTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pre-engineered steel joists
2. Bridging
3. Ceiling extensions
4. Bearing plates
5. Side wall anchors
6. Extended ends

1.2 RELATED SECTIONS

A. Steel Joist Institute, SJI:
1. Standard Specifications for Open Web Steel Joists, K-Series; and Standard Load Table, Open Web Steel Joists, K-Series.
2. Standard Specifications for Longspan Steel Joists LH Series; and Standard Load Table, Longspan Steel Joists, LH Series.
3. Standard Specifications for Deep Longspan Steel Joists, DLH Series; and Standard Load Table, Deep Longspan Steel Joists, DLH Series.
4. Standard Specifications for Joist Girders.
5. Recommended Code of Standard Practice for Steel Joists and Joist Girders.

B. American Society for Testing and Materials:
1. ASTM A36, Standard Specification for Structural Steel.
2. ASTM A307, Standard Specification for Carbon Steel Externally Threaded Standard Fasteners.

C. American Welding Society:
1. AWS A5.5, Specification for Steel, Low-Alloy, Covered Arc Welding Electrodes.
2. AWS D1.1, Structural Welding Code - Steel.

1.3 SUBMITTALS

A. Shop Drawings: Submit shop and erection drawings to include member marks, number, type, location, and spacing of members; details of bridging, extended ends and attachment at supports.

1. Reproduction of Contract Drawings shall not be used for drawings.

B. Design: Indicate on shop drawings where special designs have been provided, including a detailed, written description of magnitudes and locations of loads for each special design loading condition.

C. Submit Certified mill test reports showing compliance with requirements of ASTM and SJI Specifications.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Member of Steel Joist Institute
   2. Fabrications, handling, erection and connections of steel joists shall be in accordance with latest editions of SJI Specifications.

B. Welding Operator Qualifications:
   1. Certified within 6 months previous

1.5 DELIVERY, STORAGE AND HANDLING

A. Mark pieces for identification during erection.

B. Deliver to site in proper sequence for erection.

C. Store materials above ground; prevent corrosion, warpage and twisting.

D. Do not bend or damage members during handling.

E. Take precautions breaking bundles to prevent damage to materials and injury to workmen.

1.6 DESIGN

A. Joists shall be designed by the fabricator in accordance with the specifications of the Steel Joist Institute.

B. Where loads are shown or specified, members shall be designed for the specific loading conditions required.

C. Where loadings are not shown, members shall be designed for the maximum allowable load indicated in the standard load tables published by the Steel Joist Institute for the member designation and spans required.

D. Fabricator shall determine and include in the work any and all special bridging or temporary bracing required for proper erection or final assembly of the work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel bridging, bearing plates and wall anchors: comply with ASTM A36.

B. Bolts: comply with ASTM A307.

C. Welding Electrodes: comply with AWS A5.5, E70 or submerged arc Grade SAW-2.

D. Steel Joists: comply with SJI Specifications.
   1. Provide double angle bottom chords.
   2. Provide extended ends where required.

2.2 FABRICATION

A. Design and fabricate joists in accordance with SJI Specifications.

B. Accessories: Provide required sag rods, bridging, extended bottom chords and top chords, side wall anchors, wall connectors, headers, and ceiling extensions.

C. After fabrication, clean joists, bridging, and anchors of rust, mill scale, dirt and other foreign material. Remove grease and oil with solvents.

D. Galvanize joists.

E. Extended Ends: Design to cantilever from the main span of the joist, provide load capacity at least equal to that of joist.

F. Provide horizontal and X-bridging as required, minimum bridging requirements in accordance with SJI Specifications.

2.3 SOURCE QUALITY CONTROL

A. Laboratory Testing and Inspection
   1. Inspect fabricating and welding procedures in shop.
   2. Visually inspect shop welds.
   3. Check material certifications in shop.

PART 3 - EXECUTION

3.1 ERECTION

A. Replace joists damaged by bending or warping during handling and erection.

B. Bridging shall comply with SJI Specifications and with details on Drawings.

C. Minimum bearing and anchorage shall comply with SJI Specifications and Drawings as related to particular type of support.

D. Provide erection bolts for joists located on column centerlines.

E. Set joists to lines, levels, and spacing as indicated. Provide bearing plates as indicated or required to carry out structural requirements. Execute general handling and erection in accordance with SJI Specifications.

F. Permanently fasten joists to supports and install bridging and anchorage before any construction loads, other than workmen, are placed on joists.

G. Perform welding in accordance with AWS D1.1.

H. Properly store and protect electrodes to prevent deterioration or damage by moisture and climate.

I. After erection, touch up field connections and abraded places of galvanizing.

J. Do not weld bottom chords of joists to supports until full dead load of roof is applied. Brace joists and supporting structure for safety and stability until permanent bracing structures are in place.

K. Do not use bridging to support conduit, piping, duct work, or other equipment.

3.2 ADJUSTING

A. Correct or replace damaged materials at no additional cost to the Owner.

3.3 FIELD QUALIT CONTROL

A. Laboratory Testing and Inspection
   1. Inspect condition of materials after erection.
   2. Inspect connections to supporting structure.

END OF SECTION 052100

SECTION 053123 – METAL ROOF DECK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal Roof Deck
   2. Sheet Metal Accessories

1.2 REFERENCES (Latest Edition Available)

A. Steel Deck Institute (SDI), Specifications and Commentary for Steel Roof Deck.

B. American Iron and Steel Institute (AISI), Specification for the Design of Cold-Formed Steel Structural Members.

C. American Welding Society:
   1. AWS A5.1, Specification for Steel, Carbon, Covered Arc Welding Electrodes.
   2. AWS D1.3, Structural Welding Code - Sheet Steel.

D. American Society for Testing and Materials:
   1. ASTM A90, Standard Tests for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
   2. ASTM A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   3. ASTM A924, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
   4. ASTM A1008, Standard Specification for Steel Sheet, Cold-Rolled Sheet, Carbon, Structural.
   5. ASTM B117, Standard Salt Spray (Fog) Test.
   6. ASTM D714, Evaluating Degree of Blistering of Paints.
   7. ASTM D1654, Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

E. Underwriters Laboratories, Inc.:
   1. Bulletin of Research No. 52, Development of Apparatus and Test Method for Determining Wind Uplift Resistance of Roof Assemblies.
   2. Standard UL580, Tests for Wind Uplift Resistance of Roof Assemblies.

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings for review prior to fabrication or installation of materials.
   1. Indicate erection layouts, details, steel deck dimensions and section properties, and installation instructions. Show supporting framing, lengths and markings of deck to

correspond with sequence and procedure to be followed in installing and fastening deck. Show methods of fastening deck and installing accessories. Show locations, types and sequence of welded connections for deck units.

2. Indicate welds using standard AWS welding symbols. Show size and number of holes to be cut in deck.
3. Indicate allowable diaphragm shear capacity corresponding to pattern and type of connections provided.

1.4 QUALITY ASSURANCE

A. Acceptable Manufacturer
   1. Vulcraft
   2. Or Equal

B. Manufacturer Qualifications
   1. Member Steel Deck Institute.
   2. Minimum 5 years of experience.

C. Erector Qualifications
   1. Minimum 5 years of experience.
   2. Welders certified within previous 6 months.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver deck in bundles and store on pallets above the ground, protect from corrosion and damage. Rusted, crimped or bent deck shall not be installed in the work.

B. Do not store materials on installed deck before connecting to supporting structure.

C. Do not overload deck during construction by workmen or storage of materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Grades:
   1. ASTM A1008, Grade C for painted deck.
   2. ASTM A653, Grade A for galvanized deck.

B. Miscellaneous steel plates at vents, sump pans, and closures: 20 gage material.

C. Welding Rods: AWS A5.1, E70

D. Weld Washers: 14 gage, with 3/8ths diameter hole at center.

E. Galvanizing:

1. Wiped zinc coating, 0.2 to 0.5 ounces per square foot, complying with ASTM A924.
2. Comply with ASTM A90 and A239 for weight and uniformity.

F. Paint:
1. Resistant to solvents used to clean deck.
2. Resistant to solvents in foamed-in-place insulation.
3. Resistant to corrosion and blistering in accordance with ASTM B117, D714 and D1654.

2.2 MANUFACTURED UNITS

A. Metal deck units shall comply with the Specifications of the Steel Deck Institute.

B. Design units for required spans and conditions of continuity, generally for 3 continuous spans, except as required by layout.

C. Stresses under construction loads, gravity loads and wind loading shall not exceed recommendations of the Steel Deck Institute.

2.3 FABRICATION

A. Fabricate in lengths as long as practical and piece-mark bundles for identification during erection.

B. Painting:
1. Thoroughly clean deck and coat both sides with phosphate prior to painting.
2. Apply paint .30 mils minimum thickness to both sides of deck and heat cure for tough, abrasion-resistant finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not lay deck units in place until supporting structure is secured in place and final connections are complete.

B. Layout deck units in accordance with shop drawings, do not stretch or bend units.

C. Overlap ends a minimum of 2 inches. Interlock side laps as shown on shop drawings.

D. Connections:
1. Anchor deck to supporting steel with full-fusion puddle welds. Use weld washers where required.
2. Connect side laps with screws or welds.
3. Side lap connections of interlocking edges shall be made by button-punching with a specially designed crimping tool.

E. Weld metal fillers and closure pieces in place.

3.2 FIELD QUALITY CONTROL

A. Laboratory Testing and Inspection:
   1. Inspect condition of deck units for damage and corrosion.
   2. Inspect connections of deck to structure and at side laps.

3.3 ADJUSTING

A. Touch-up scarred areas on both sides of deck including welds, rust spots and abrasions by wire-brushing and painting with shop paint.

B. Repair blow-holes at welds with 18 gage plates welded in place. Replace entire sections of deck where holes cannot be satisfactorily repaired.

3.4 HANGERS FOR MISCELLANEOUS EQUIPMENT

A. Do not attach hangers for ceilings, ductwork, or piping directly to metal roof deck.

END OF SECTION 053123

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Shelf angles.
3. Metal ladders.
4. Ladder safety cages.
5. Metal floor plate and supports.
6. Structural-steel door frames.
7. Miscellaneous steel trim.
8. Metal bollards.
9. Pipe guards.
10. Abrasive metal nosings, treads, and thresholds.
11. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section include the following:

1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Metal nosings and treads.
2. Paint products.
3. Grout.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Samples for Verification: For each type and finish of extruded nosing and tread.

D. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ladders.

B. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304 and Type 316.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

F. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.

G. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

H. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

I. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: As indicated.
2. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B, with G90 coating; 0.108-inch nominal thickness.
3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, commercial steel, Type B; 0.0966-inch minimum thickness; hot-dip galvanized after fabrication.

J. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

K. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

L. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

M. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

N. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).

O. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

P. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

Q. Corrosion Protection: Unless otherwise shown, miscellaneous metalwork of fabricated steel, which will be used in a corrosive environment and/or will be submerged in water/wastewater shall be coated in accordance with Section 098000 "Protective Coatings" and shall not be galvanized prior to coating. All other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication as specified herein.

R. Stainless Steel: Stainless steel metal work shall be of Type 316 stainless steel.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.
3. Provide stainless-steel fasteners for fastening nickel silver.
4. Provide bronze fasteners for fastening bronze.

B. Steel Bolts and Nuts: Except as otherwise specified herein, steel for bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A 307 Grade B, or threaded parts of ASTM A 36 and shall meet the following additional requirements

1. The nut material shall be free-cutting steel.
2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
3. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.

C. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F 593; with hex nuts, ASTM F 594: and, where indicated, flat washers; Alloy Group 1. Unless otherwise shown or approved, all bolts, anchor bolts, washers and nuts which are buried, submerged or below the top of the wall inside any hydraulic structure shall be of Type 316 stainless steel.

D. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

E. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

F. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

E. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" .

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

C. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended.

D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

E. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 8 inches from ends and corners of units and 24 inches o.c.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

C. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.7 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with primer specified in Section 098000 "Protective Coatings."

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.

B. Steel Ladders:

1. Ladders which may be partially or wholly submerged or which are located inside a hydraulic structure shall be entirely of Type 316 stainless steel. All other ladders shall be of carbon steel, hot-dip galvanized after fabrication unless noted otherwise on the drawings.
2. Space siderails 18 inches apart unless otherwise indicated.
3. Siderails: As indicated.
4. Rungs: 1/2-inch- diameter steel bars.
5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
6. Provide nonslip surfaces on top of each rung.

2.9 LADDER SAFETY CAGES

A. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.

B. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.

C. Hot-dip galvanize steel ladder safety cages, including brackets and fasteners.

2.10 METAL FLOOR PLATE

A. Fabricate from rolled-stainless-steel floor plate of thickness indicated below:

1. Thickness: As indicated.

B. Provide stainless-steel angle supports as indicated.

C. Provide flush stainless-steel bar drop handles for lifting removable sections, one at each end of each section.

2.11 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops. Plug-weld built-up members and continuously weld exposed joints. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Galvanize exterior steel frames.

C. Prime exterior steel frames with primer specified in Section 098000 "Protective Coatings."

2.12 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

C. Galvanize exterior miscellaneous steel trim.

D. Prime exterior miscellaneous steel trim with primer specified in Section 098000 "Protective Coatings."

2.13 METAL BOLLARDS

A. Fabricate metal bollards from 1/4-inch wall-thickness, steel shapes, as indicated.

B. Prime and coat bollards with coatings specified in Section 098000 "Protective Coatings."

C. For removable bollard requirements, see Drawings.

2.14 PIPE GUARDS

A. Fabricate pipe guards from 3/8-inch- thick by 12-inch- wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard. Drill each end for two 3/4-inch anchor bolts.

B. Galvanize pipe guards.

C. Prime pipe guards with primer specified in Section 098000 "Protective Coatings."

2.15 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

A. Cast-Metal Units: Cast aluminum, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c.

D. Apply bituminous paint to concealed surfaces of cast-metal units.

E. Apply clear lacquer to concealed surfaces of extruded units.

2.16 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.17 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.18 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

2.19 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 098000 "Protective Coatings" are indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 098000 "Protective Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

B. Anchor bollards in concrete. Fill annular space around bollard solidly with concrete.

C. Anchor bollards in place with concrete footings. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

D. Fill bollards solidly with concrete, mounding top surface to shed water.

E. For removable bollard installation requirements see Drawings.

3.3 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION

SECTION 055100 - METAL STAIRS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel-framed stairs.
2. Aluminum-framed stairs.
3. Aluminum tube railings attached to metal stairs.

B. See Section 055213 "Pipe and Tube Railings" for pipe and tube railings not attached to metal stairs or to walls adjacent to metal stairs.

C. See Section 055300 “Metal Grating” or Section 067413 “Fiberglass Reinforced Grating” for tread requirements.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor is 1.5.

1.3 ACTION SUBMITTALS

A. Product Data: For metal stairs.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Delegated-Design Submittal: Provide design data and analysis signed and sealed by a registered professional engineer in the State of California, responsible for their preparation.

1.4 QUALITY ASSURANCE

A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Preassembled Stairs: Commercial class.
2. Industrial-Type Stairs: Industrial class.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500 (cold formed).

D. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.

E. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.

F. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

G. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

H. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.

I. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

J. Fasteners: Provide stainless steel fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

2.2 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.
3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without impairing work.

E. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.

G. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.3 ALUMINUM-FRAMED STAIRS

A. Stair Framing:

1. Fabricate stringers of aluminum plates or channels.
2. Construct platforms of aluminum plate or channel headers and miscellaneous framing members as needed to comply with performance requirements.
3. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below.

5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

2.4 STEEL-FRAMED STAIRS

A. Stair Framing:

1. Fabricate stringers of steel plates or channels.
2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements.
3. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below.
5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

B. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.067 inch.

1. At Contractor's option, provide stair assemblies with metal-pan subtreads filled with reinforced concrete during fabrication.
2. Provide epoxy-resin-filled treads, reinforced with glass fibers, with slip-resistant, abrasive surface.

C. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.097 inch. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

D. Metal Floor Plate Stairs: Form treads and platforms to configurations shown from rolled-steel floor plate of thickness needed to comply with performance requirements, but not less than 1/8 inch. Form treads with integral nosing and back edge stiffener. Weld steel supporting brackets to stringers and weld treads to brackets.

E. Metal Bar-Grating Stairs: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from steel grating with crossbars at 4 inches o.c.
2. Fabricate grating treads with nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.

2.5 ALUMINUM BAR GRATING

A. Where aluminum stairs are indicated, use aluminum bar grating, in accordance with Section 055300, “Metal Grating”.

B. Where fiberglass reinforced plastic stairs are indicated, use FRP bar grating, in accordance with Section 067413, “Fiberglass Reinforced Grating”.

2.6 STAIR RAILINGS

A. Aluminum Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: 1-1/2-inch- square top and bottom rails and 1-1/2-inch- square posts.
2. Picket Infill: 1/2-inch- square pickets spaced less than 4 inches clear.

B. Riveted Connections: Fabricate railings with riveted connections.

C. Form changes in direction of railings with fittings.

D. Form curves by bending members in jigs to produce uniform curvature without buckling.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.

1. Connect posts to stair framing by direct welding.

H. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, to transfer wall bracket loads through wall finishes. Size fillers to suit wall finish thicknesses.

2.7 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

B. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.

D. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

E. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."

1. Install abrasive nosings with anchors fully embedded in concrete.

F. Install precast concrete treads with adhesive supplied by manufacturer.

G. Attach handrails to wall with wall brackets. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.

3.2 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aluminum pipe and tube railings.

B. See Section 055100 "Metal Stairs" for tube railings associated with metal stairs.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

   1. Handrails and Top Rails of Guards:

      a. Uniform load of 50 lbf/ ft. applied in any direction.
      b. Concentrated load of 200 lbf applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.

   2. Infill of Guards:

      a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
      b. Infill load and other loads need not be assumed to act concurrently.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Manufacturer's product lines of mechanically connected railings.
   2. Railing brackets.
   3. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Delegated-Design Submittal: Provide design data and analysis signed and sealed by qualified registered professional engineer in the State of California, responsible for their preparation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.2 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Tubing: ASTM B 221, Alloy 6063-T5/T52.

C. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.

D. Drawn Seamless Tubing: ASTM B 210, Alloy 6063-T832.

E. Plate and Sheet: ASTM B 209, Alloy 6061-T6.

F. Die and Hand Forgings: ASTM B 247, Alloy 6061-T6.

G. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

H. Perforated Metal: Aluminum sheet, ASTM B 209, Alloy 6061-T6, 0.063 inch thick, with 1/4-inch holes 3/8 inch o.c. in staggered rows.

2.3 ALUMINUM RAILING SYSTEM

A. Rails: 1 1/2 inch diameter, extruded tubing to match existing.

B. Fittings: Elbows, T shapes, wall bracket, escutcheons, cast or machined aluminum to match existing.

C. Mounting: Adjustable or demountable brackets and flanges (as specified in drawings), with aluminum inserts for casting in concrete.

D. Splice Connectors: Concealed spigot or to match existing.

E. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.

F. Finish: Anodized or to match existing.

2.4 MISCELLANEOUS MATERIALS

A. Fasteners: Provide the following:

1. Hot-Dip Galvanized Railings: Type 316 stainless-steel fasteners.
2. Aluminum Railings: Type 316 stainless-steel fasteners.
3. Stainless-Steel Railings: Type 316 stainless-steel fasteners.

B. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

C. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

E. Support Brackets: Handrail support brackets shall match the same material of the handrails with a finish that matches the handrail or railing of which they are a part.

F. Toeboards: Toeboard for pipe railing shall be as indicated.

G. Socket Grout: Non-shrink grout for handrail post sockets shall consist of an inorganic, non-metallic, pre-mixed grout with a minimum 28-day compressive strength of 4,000 psi.

2.5 FABRICATION

A. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Form work true to line and level with accurate angles and surfaces.

C. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

D. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.

E. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

F. Bend members in jigs to produce uniform curvature without buckling or otherwise deforming exposed surfaces.

G. Close exposed ends of railing members with prefabricated end fittings.

H. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers to transfer loads through wall finishes.

2.6 ASSEMBLIES

A. Height and Spacing Requirements: Railing shall be a three (3) rail system with equal open spaces between rails (and toeboard when required). The spacing shall meet the IBC and California OSHA requirements (whichever is more stringent). Top of upper railing shall be 42-inches above the working surface. Toeboards shall be not less than 4-inches in height or more than 1/4-inch off the working surface and shall be provided where indicated and/or required. Railings shall be mounted as shown on the Drawings. The posts shall be evenly spaced at not less than 4-feet (unless otherwise indicated on the Drawings) nor more than 6-feet on centers. Field conditions may require some adjustment of spacing. The top railings shall be as long as possible and the post shall not project through the top rails.

PART 3 - EXECUTION

3.1 GENERAL

A. Unless specified or shown otherwise, all handrails and railings shall be component systems, installed complete and ready for use with all anchors, attachments, balusters, brackets, caps, fasteners, gates, posts, sleeves, trim and all other related items required or necessary for the complete installation.

B. All installation work hereunder shall be performed by craftsmen experienced in the fabrication or architectural metal work. Exposed surfaces shall be free from defects or other surface blemishes. All dimensions and conditions shall be verified in the field in advance. All joints, junctions, miters and butting sections shall be precision-fitted with no gaps occurring between sections and all surfaces shall be flush and aligned

3.2 INSTALLATION

A. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

B. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, in accordance with the requirements of technical specification 098000 “Protective Coatings”.

C. Weld finish: All exposed welds shall be ground smooth and flush and shall be polished and anodized. Discoloration of exposed aluminum surfaces, whether or not due to welding, shall constitute a basis for rejection of the entire assembly.

D. Expansion/Contraction: Exterior railing systems shall provide for 1/4-inch expansion and contraction per 20 linear feet of railing. Interior railing systems shall provide for 1/8-inch expansion or contraction per 20 linear feet of railing.

E. Railing Continuity and End Treatment: Handrails and railings shall be designed to form a continuous run system with elbow turns and bends that do not have interferences with hand movement. Handrails shall be continuous for the full length of the stairs and landings. The handrails shall extend not less than 6-inches beyond the top and bottom risers. Whenever possible, the extension shall be at least 18-inches for the possible use by handicapped people. The ends of handrails shall be returned to wall or shall be terminated in newel posts or safety terminals. Newel posts and safety terminals may be used only when approved by the Engineer.

F. Anchor posts in concrete by inserting into preset metal pipe sleeves and grouting annular space.

G. Anchor railing ends at walls with round flanges anchored to wall construction.

H. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces.

I. Attach railings to wall with wall brackets. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.

J. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055213

SECTION 055300 - METAL GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal bar gratings.
2. Formed-metal plank gratings.
3. Metal frames and supports for gratings.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design gratings and grating supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Floors: Uniform load of 125 lbf/sq. ft. or concentrated load of 2000 lbf whichever produces the greater stress.
2. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft.
3. Walkways and Elevated Platforms Used as Exits: Uniform load of 100 lbf/sq. ft.
4. Sidewalks and Vehicular Driveways, Subject to Trucking: Uniform load of 250 lbf/sq. ft. or concentrated load of 8000 lbf, whichever produces the greater stress.
5. Unless noted otherwise, deflection of grating shall not exceed ¼" under the loading described above.

C. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Formed-metal plank gratings.
2. Clips and anchorage devices for gratings.
3. Paint products.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Delegated-Design Submittal: Provide design data and analysis signed and sealed by a registered professional engineer in the State of California, responsible for their preparation.

1.4 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual " and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."

PART 2 - PRODUCTS

2.1 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

C. Wire Rod for Bar Grating Crossbars: ASTM A 510 (ASTM A 510M).

D. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30 (Grade 205).

E. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating.

F. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.

G. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

2.2 ALUMINUM

A. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), alloys as follows:

1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
2. 6061-T1, for grating crossbars.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.4 MISCELLANEOUS MATERIALS

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.5 FABRICATION

A. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

C. Fit exposed connections accurately together to form hairline joints.

D. Fabricate toeplates for attaching in the field.

2.6 METAL BAR GRATINGS

A. Pressure-Locked, Aluminum I-Bar Grating, unless noted otherwise on drawings:

1. Bearing Bar Spacing: 1-3/16 inches
2. Bearing Bar Depth: 2 inch.
3. Bearing Bar Flange Width: 1/4 inch.
4. Crossbar Spacing: 4 inches o.c.
5. Traffic Surface: Grooved.
6. Aluminum Finish: Class I, clear, anodized finish.

B. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.

C. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

D. Do not notch bearing bars at supports to maintain elevation.

2.7 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.

2.8 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

C. Shop prime gratings, frames and supports unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

B. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Attach toeplates to gratings by welding at locations indicated.

D. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055300

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Framing with engineered wood products.
3. Shear wall panels.
4. Rooftop equipment bases and support curbs.
5. Wood blocking, cants, and nailers.
6. Wood furring.
7. Wood sleepers.
8. Plywood backing panels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Provide dressed lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

C. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all rough carpentry unless otherwise indicated:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 DIMENSIONAL LUMBER FRAMING

A. Maximum Moisture Content: 19 percent.

B. Wall Studs: Stud or No. 2 grade, Douglas Fir – Larch, WCLIB or WWPA grading rules.

C. Wall Plates: No. 2 or Construction grade, Douglas Fir – Larch, WCLIB or WWPA grading rules.

D. Framing Other Than Noted Above: No. 2 grade or better, Douglas Fir – Larch, WCLIB or WWPA grading rules.

E. Exposed Framing: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.

F. Species: As indicated above for load-bearing construction of same type.

G. Grade: No. 1.

2.4 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are required, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

2.5 ENGINEERED WOOD PRODUCTS

A. Engineered Wood Products, General: Products shall contain no urea formaldehyde.

2.6 SHEAR WALL PANELS

A. Plywood: Plywood shall conform to the requirements of U.S. Product Standard PS 1 as specified herein. All plywood panels shall be marked with grade mark of the American Plywood Association. The mark shall identify the plywood as to species, glue type and grade in compliance with the applicable commercial standard. Except as otherwise specified below or shown, plywood shall be Douglas Fir, Exterior, C-D, SIS. Plywood for other specific applications shall be as follows:

1. Plywood for use in concrete forms shall conform to the requirements of Section 033000 “Cast-In-Place Concrete".
2. Plywood for backup boards behind telephone equipment, electrical equipment or communication equipment shall be Douglas Fir, A-C EXT grade for interior and exterior locations.

B. Hardboard: Hardboard shall be temper-treated panels manufactured from interfelted lingo-cellulose fibers consolidated under heat and pressure in a hot press to produce a smooth, hard-surfaced material which is resistant to water and stains. Hardboard shall conform to the requirements of PS 58.

2.7 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.

5. Furring.
6. Grounds.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine; No. 2 grade; SPIB.
2. Eastern softwoods; No. 2 Common grade; NeLMA.
3. Northern species; No. 2 Common grade; NLGA.
4. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

2.8 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Power-Driven Fasteners: NES NER-272.

C. Bolts: Steel bolts complying with ASTM A 307, Grade B; with ASTM A 563 hex nuts and, where indicated, flat washers.

2.9 METAL FRAMING ANCHORS

A. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of basis-of-design products. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.

1. Use for interior locations unless otherwise indicated.

C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.

1. Use for wood-preservative-treated lumber and where indicated.

2.10 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

1. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

D. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

E. Shear Wall Panels: Install shear wall panels to comply with manufacturer's written instructions.

F. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

G. Do not splice structural members between supports unless otherwise indicated.

H. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. "Fastening Schedule," in IBC.

END OF SECTION 061000

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SECTION 065100 – FIBERGLASS REINFORCED PLASTIC WEIRS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. Contractor shall supply and install all FRP weirs as indicated in the design drawings.

1.2 REFERENCES

A. ANSI/AWWA F102 - Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates, Scum Baffles, and Mounting Brackets; American Water Works Association.

B. ASTM D 256 - Standard Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.

C. ASTM D 570 - Standard Test Method for Water Absorption of Plastics.

D. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.

E. ASTM D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C.

F. ASTM D 790 - Standard Test Methods for Flexural Properties of non-reinforced and Reinforced Plastics and Electrical Insulating Materials.

G. ASTM D 2583 - Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

1.3 SUBMITTALS

A. Submit under provisions of Section 013300.

B. Product Data: Test results of fiberglass reinforced plastic laminate.

C. Critical dimensions, jointing and connections, fasteners and anchors.

D. Materials of construction.

E. Sizes, spacing, and locations of structural members, connections, attachments, openings, fasteners, and loads.

F. Manufacturer's installation instructions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products indoor and protect from construction traffic and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Warminster Fiberglass Company

B. Or Equal

2.2 WEIR PLATES

A. Weir Plates, Scum Baffles, Brackets, and Plates: Fiberglass reinforced polyester resin, compression molded in matched metal die molds; provide all required lap plates, cover plates, and support brackets.

B. Plates fabricated from cut plate stock with cut edges, notches, etc., will not be accepted.

C. Fiberglass Laminate Construction: Sheet Molding Compound (SMC) for use in water treatment systems.

1. Glass content of laminate; 20 percent plus/minus 3 percent by weight. Resin fillers: 40 percent plus/minus 2 percent of resin mixture.
2. Final laminate thickness: Plus/minus 10 percent of nominal specified thickness.
3. Tensile strength (ASTM D 638): 10,000 psi.
4. Flexural strength (ASTM D 790): 20,000 psi.
5. Flexural modulus (ASTM D 790): 800,000 psi.
6. Impact, notched, Izod (ASTM D 256): 10 ft-lb
7. Barcol hardness (resin-rich surface) (ASTM D 2583): 35 minimum, average.
8. Water absorption (ASTM D 570): 0.2 percent at 24 hrs.
9. Coefficient of thermal expansion, ave. (ASTM D 696): 0.0000105 in/in/degree F.
10. Test coupons prepared in accordance with ASTM D 618.
11. Chemical resistance: Comply with ANSI/AWWA F102, Type II classification.

D. Weir Plates:

1. 1/4-inch nominal thickness.
2. Color: Turquoise.
3. Height: 10-inches.
4. Length: Nominal 5 OR 7 feet long.
5. Mounting holes on rectangular tanks: 4 each, 2 1/2-inches square at 12-inches on center to provide a minimum 2-inches vertical or horizontal adjustment.
6. Mounting: 5/8-inch diameter 316 stainless steel expansion anchor bolts and 5-inch square fiberglass cover plates to prevent short-circuiting of water.
7. Ends secured with 6 by 10 inch high lap plates to allow for horizontal expansion.

E. Lap Plates:

1. Size: 6 by 10 inches.
2. Provide as required to secure ends of weir plates.
3. Provide 316 stainless steel hardware to secure weir plates to concrete wall and to lap plates.

F. Assembly Hardware:

1. Expansion Anchor Bolts w/ Nuts and Washers:

a. Stainless Steel Type 316
b. 5/8 inch diameter by 6 inches

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Ensure that products are installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer and as indicated in the contract documents.

C. Install in accordance with approved shop drawings and in true and proper alignment.

D. Adjust weir plate elevation for flow indicated or as directed by the Engineer.

E. When necessary to adjust lengths of plates due to field conditions and when approved by the Engineer, seal cut or machined edges thus exposed with polyester resin. Excessive cutting will not be acceptable.

3.3 ADJUST AND CLEAN

A. Clean surfaces in accordance with manufacturer's instructions.

END OF SECTION 065100

SECTION 065300 - FIBERGLASS REINFORCED PLASTIC PLANKING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 SCOPE OF WORK:

A. Furnish all labor, materials, equipment and incidentals necessary to install the fiberglass reinforced polymer (FRP) products as specified herein.

1.3 QUALITY ASSURANCE

A. The material covered by these specifications shall be furnished by an ISO-9001:2000 certified manufacturer of proven ability who has regularly engaged in the manufacture and installation of FRP systems.

B. Substitution of any component or modification of system shall be made only when approved by the Architect or Engineer.

C. Fabricator Qualifications: Firm experienced in successfully producing FRP fabrications similar to that indicated for this project, with sufficient production capacity to produce required units without causing delay in the work.

D. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.4 DESIGN CRITERIA

A. The design of FRP products including connections shall be in accordance with governing building codes and standards as applicable.

B. Design live loads of FRP gratings and floor panels shall not be less than 150 PSF uniformly distributed unless specifically stated otherwise in drawings and/or supplementary conditions. Grating and floor panel deflection at the center of a simple span not to exceed 0.125".

C. Structural members shall be designed to support all applied loads. Deflection in any direction shall not be more than L/180 of span for structural members. Connections shall be designed to transfer the loads.

1.5 SUBMITTALS

A. Shop drawings of all fabricated pultruded gratings and treads, structural shapes and plate, standard railings, ladders and cages, foam core building panels, building panel systems, planks, molded gratings and treads and appurtenances shall be submitted to the Engineer for approval in accordance with the requirements of Section 013300. Fabrication shall not start until receipt of Engineer's approval marked "Approved As Submitted" or "Approved As Noted".

B. Manufacturer's catalog data showing

1. Dimensions, spacings, and construction of grating
2. Materials of construction

C. Detail shop drawings showing

1. Dimensions
2. Sectional assembly
3. Location and identification mark
4. Size and type of supporting frames required

D. Samples of each type of product shall be submitted for approval prior to placement of purchase orders.

1.6 SHIPPING AND STORAGE INSTRUCTIONS

A. All systems, sub-systems and structures shall be shop fabricated and assembled into the largest practical size suitable for transporting.

B. All materials and equipment necessary for the fabrication and installation of planks shall be stored before, during, and after shipment in a manner to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to the materials or equipment, including damage due to over exposure to the sun. Any material which, in the opinion of the Engineer, has become damaged as to be unfit for use, shall be promptly removed from the site of work, and the Contractor shall receive no compensation for the damaged material or its removal.

C. Identify and match-mark all materials, items and fabrications for installation and field assembly.

PART 2 – PRODUCTS

2.1 GENERAL

A. Materials used in the manufacture of the FRP products shall be raw materials in conformance with the specification.

B. All materials shall be of the kind and quality specified.

C. With the exception of molded gratings and treads, all FRP products shall be manufactured using a pultruded process utilizing polyester or vinyl ester (as recommended by the manufacturer for each installation site) resin with flame retardant and ultraviolet (UV) inhibitor additives. A synthetic surface veil shall be the outermost layer covering the exterior surface. The flame retardant FRP shapes shall achieve a flame spread rating of 25 or less in accordance with ASTM test method E-84. (Polyester resin is available without flame retardant and UV inhibitor additives.)

D. If required, after fabrication, all cut ends, holes and abrasions of FRP shapes shall be sealed with a compatible resin coating.

E. FRP products exposed to weather shall contain an ultraviolet inhibitor. Should additional ultraviolet protection be required, a one mil minimum UV coating can be applied.

F. All exposed surfaces shall be smooth and true to form.

G. Manufacturers:

1. Strongwell
2. Or equal

2.2 FIBERGLASS PLANKS

A. General

1. FRP planks shall be shipped from the manufacturer, palletized and banded with exposed edges protected to prevent damage in shipment.
2. Each piece shall be clearly marked showing manufacturer's applicable drawing number.
3. FRP planks shall be SAFPLANK® as manufactured by Strongwell or equal.

B. Design

1. The panels shall be 2" deep and sustain a deflection of no more than 0.125" under a uniform distributed load of 150 PSF for the span lengths shown on the plans.
2. FRP planks shall be capable of withstanding a uniform load of 150 PSF or a concentrated load of 300 lbs. on an area of 4 sq. inches located in the center of the plank.
3. The top surface of all panels shall have non-skid grit.
4. Panels shall be fabricated to the sizes shown on the drawings.
5. Hold down clamps shall be surface mounted type 316L stainless steel. A minimum of 2 each per panel as provided by Strongwell or an equal clamp.
6. Color shall be gray.

C. Products

1. The FRP planks shall be manufactured by the pultrusion process. The planks shall be 2" deep and 12" or 24" wide (as detailed in the drawings) with interlocking joints on outside legs of plank. The glass fiber reinforcement for the planks shall be a core of continuous glass strand rovings wrapped with continuous strand glass mat. A synthetic surface veil shall be the outermost layer covering the exterior surfaces.
2. Fiberglass planks shall be made from a fire retardant isophthalic polyester resin system that meets the flame spread rating of 25 or less in accordance with ASTM E-84 testing and meets the self-extinguishing requirements of ASTM D-635. UV inhibitors are added to the resin.

PART 3 – EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and

miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

B. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from infiltration of water and debris.

3.2 INSPECTION AND TESTING

A. The Engineer shall have the right to inspect and test all materials to be furnished under these specifications prior to their shipment from the point of manufacture.

B. All labor, power, materials, equipment and appurtenances required for testing shall be furnished by the Contractor at no cost to the Owner.

3.3 INSTALLATION, GENERAL

A. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as determined by the Engineer.

B. Cutting, fitting and placement: Perform cutting, drilling and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment and elevation; with edges and surfaces level, plumb, true and free of rack; measured from established lines and levels.

C. Provide temporary bracing or anchors in form work for items that are to be built into concrete masonry or similar construction.

D. Ensure that installation will allow for reasonable temporary removal to access underlying equipment, gates, valves or other equipment,

3.4 ALL FRP INSTALLATION

A. If required, all field cut and drilled edges, holes and abrasions shall be sealed with a catalyzed resin compatible with the original resin as recommended by the manufacturer. The sealing of the edges shall prevent premature fraying at the field cut edges.

B. Install items specified as indicated and in accordance with manufacturer’s instructions.

END OF SECTION 065300

SECTION 065310 – FIBERGLASS BAFFLE WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes all fiberglass polyester (FRP) baffle partitions and walls required including all frames, mounting hardware and all associated components to provide a complete and functioning baffle wall.

1.2 REFERENCES:

A. Design, fabricate, and test FRP baffle walls in accordance with manufacturer's recommended procedures and the following codes and standards:

1.	ASTM A193	Stainless Steel Anchor Bolts
2.	ASTM D256	Izod Impact Strength
3.	ASTM D570	Water Absorption Rate
4.	ASTM D638	Tensile Strength
5.	ASTM D695	Compressive Properties of Rigid Plastic
6.	ASTM D696	Coefficient of Linear Expansion
7.	ASTM D790	Flexural Properties
8.	ASTM D792	Density of Specific Gravity at 23 degrees C
9.	ASTM D2563-0	Visual Defects
10.	ASTM D2583	Indentation Hardness
11.	ASTM D2584	Resin, Glass & Filler Content

B. Composition of the FRP baffle wall shall be in accordance with the recommendations shown in the Quality Assurance Report for Reinforced Thermoset Plastic (RTP) Corrosion Resistant Equipment prepared under the sponsorship of the Society of the Plastics Industry, Inc. (SPI), and the Material Technology Institute (MTI) of the Chemical Process Industry for "Hand Lay-Up Laminates," and shall meet the specifications for Type I, Grade 10 laminates shown in Appendix M-1 of said report.

C. The fully assembled gates shall be shop inspected. There shall be no assembling or adjusting on the job sites.

1.3 SUBMITTALS

A. The manufacturer shall submit for approval by the purchaser, drawings showing the principal dimensions, general construction and materials used in the baffle plate, including plate the number and size of each individual baffle plate, the mounting and support method to install the gate and support members, and the configuration, size and number of any openings in the baffle plate.

B. The manufacturer shall submit for approval by the purchaser, complete engineering design calculations in compliance with AWWA standards latest edition. Submittal shall also include

calculations for deflection and, where applicable, headloss through the openings in the baffle wall.

1.4 DELIVERY, STORAGE AND HANDLING

A. Ship all gates with suitable packaging to protect products from damage. Protect all products and unload, handle, and store in accordance with all manufacturer recommendations. Protect corners and protruding accessories form damage.

1.5 PERFORMANCE

A. Manufacturer must provide warranty for 25 years against corrosion of the baffle wall and associated components.

PART 2 - PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

A. Baffle walls and framing systems, where required, shall be designed to meet the requirements listed herein, accounting for hydraulic forces exerted on the system, including impulsive and convective forces

B. Baffle wall shall be engineered composite fiberglass reinforced plastic (FRP) sandwich construction completely encapsulation an internal structure. Construction shall be molded to create a seamless corrosion barrier impervious to moisture. Internal steel reinforcing shall be carbon steel as needed for deflection requirements.

C. Baffle wall shall be molded in one piece with a minimum thickness of 1-inch polyurethane foam encapsulated between 1/8-inch minimum fiberglass reinforced skins. The resin and gelcoat shall be UV inhibited.

D. The exterior surfaces shall be finished with a premium grade gelcoat for superior protection against weathering and discoloration. The surface shall be resin rich to a depth of 0.10 inches to 0.20 inches.

E. The exterior surface finish shall be smooth to allow easy access for cleaning and maintenance.

F. There shall be a bolting flange on the bottom wall panel and on each side of each panel to facilitate mounting the baffle to the structure.

G. Fiberglass baffle wall supplier shall include all mounting material and hardware, including fiberglass angles, channels, brackets, and all bolts and anchors. Anchors shall be T-316L stainless steel. The manufacturer shall provide anchorage calculations, signed and sealed by a professional engineer registered in the State of California.

H. Internal core foam shall be 2lb polyisocyanurate closed cell rigid foam. Foam core must be 100% resistant to decay and attack by fungus and bacteria and be resistant to hydrocarbons.

I. Individual baffle wall panels shall be individually removable to allow for maintenance or access. Each baffle plate shall be of the dimensions and provide the opening size, placement, and orientation as indicated in the design drawings. Alternate baffle plate design and opening configuration must be approved by the Engineer.

J. FRP baffle walls shall be as manufactured by Plasti-Fab (design basis) or equal.

K. Visual inspections for defects shall be made without the aid of magnification and defects shall be classified as to type and level as shown in Table 1 of ANSI/ASTM D2563-0, approved 1977. (or any subsequent revision). Allowable surface tolerances are as follows:

1. No cracks, crazing, blisters, chips, pits, dry spots, fish eyes, burned areas, surface porosity, exposed glass or entrapped air is acceptable.
2. Scratches must be no more than 0.002-inches deep and wrinkles and solid blisters shall not exceed 1/8".
3. No foreign material shall be present.

L. Deflection across the baffle wall width shall be limited to L/360 or 1/4", whichever is less at the maximum operating head.

M. All baffle walls shall be flat and level. Warpage throughout the entire baffle wall shall not produce a crown of more than 1/16-inch in any direction.

N. Physical Properties for the glass mat laminate shall meet the following minimum requirements:

Tensile strength	15,000 psi (1034 ksc)
Flexural Modulus	1,000,000 psi (70307 ksc)
Flexural Strength	20,000 psi (1406 ksc)
Compressive Strength	22,000 psi (1547 ksc)
Impact Strength	9.0 ft-lbs/in. (1.24 kgf.m/25mm)
Water absorption	0.13% (in 24 hours)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Thoroughly clean and remove all shipping materials prior to setting.

B. Install baffle walls per manufacturer's recommendations.

C. Baffle walls shall be inspected under normal operating conditions (i.e. maximum seating or un-seating head conditions) to ensure proper installation and satisfactory performance including deflection and headloss.

END OF SECTION

SECTION 067413 – FIBERGLASS REINFORCED GRATING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

B. ANSI/ACMA/FGMC FRP Composites Grating Manual for Pultruded and Molded Grating and Stair Treads.

1.2 SUMMARY:

A. This section includes FRP Products & Fabrications for FRP Pultruded Gratings and Stair Treads.

1.3 SCOPE OF WORK:

A. Furnish all labor, materials, equipment and incidentals governed by this section necessary to install the fiberglass reinforced polymer (FRP) products as specified herein.

1.4 QUALITY ASSURANCE:

A. The material covered by these specifications shall be furnished by an ISO-9001 certified manufacturer of proven ability who is regularly engaged in the manufacture, fabrication and installation of FRP systems.

B. Substitution of any component or modification of system shall be made only when approved by the Architect or Design Engineer.

C. Fabricator Qualifications: Firm experienced in successfully producing FRP fabrications similar to that indicated for this project, with sufficient production capacity to produce required units without causing delay in the work.

D. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.5 DESIGN CRITERIA:

A. The design criteria of the FRP pultruded grating, including connections, shall be in accordance with governing building codes and accepted standards in the FRP composites industry.

B. Gratings: Design live loads of FRP gratings for walkway applications shall be 60 psf uniformly distributed load per ASCE 7 or as required by the governing building code with a maximum deflection of 0.25" at the center of a simple span.

C. Stair Treads: Stair treads shall be designed for a uniform load of 100 psf per ASCE 7 or a concentrated load of 300 lbs on an area of 4 sq. inches located in the center of the tread, whichever produces greater stress and deflect less than 0.25". The two loads do not act concurrently.

D. Structural support members shall not deflect more than L/180 of span for structural members unless specifically stated otherwise in drawings and/or supplementary conditions. Connections shall be designed to transfer the design loads.

E. Temperature exposure is limited to those listed in Division 1 of the Specifications.

1.6 SUBMITTALS:

A. Shop drawings of all fabricated pultruded gratings and treads shall be submitted to the Design Engineer for approval in accordance with the requirements of Section 013300. Fabrication shall not start until receipt of Design Engineer's approval marked "Approved As Submitted" or "Approved As Noted".

B. Manufacturer's catalog data showing:
   1. Materials of construction
   2. Dimensions, spacings, and construction of grating, handrails and building panels.

C. Detail shop drawings showing:
   1. Dimensions
   2. Sectional assembly
   3. Location and identification mark
   4. Size and type of supporting frames required

1.7 SHIPPING AND STORAGE INSTRUCTIONS:

A. All gratings and components shall be shop fabricated and assembled into the largest practical size suitable for transporting.

B. All materials and equipment necessary for the fabrication and installation of pultruded gratings and treads and appurtenances shall be stored before, during, and after shipment in a manner to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to the materials or equipment, including damage due to over exposure to the sun. Any material which, in the opinion of the Design Engineer, has become damaged as to be unfit for use, shall be promptly removed from the site of work, and the Contractor shall receive no compensation for the damaged material or its removal.

C. Identify and match-mark all materials, items and fabrications for installation and field assembly.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Materials used in the manufacture of the FRP products shall be raw materials in conformance with the specification and certified as meeting the manufacturer's approved list of raw materials.

B. All raw materials shall be as specified by the contract.

C. The visual quality of the pultruded shapes shall conform to ASTM D4385.

D. FRP pultruded grating and treads shall be manufactured using a pultruded process utilizing polyester, vinyl ester or phenolic resin with flame retardant and ultraviolet (UV) inhibitor

additives. Unless a phenolic resin system is utilized, a synthetic surface veil fabric shall encase the glass reinforcement. FRP shapes shall achieve a flame spread rating of 25 or less in accordance with ASTM test method E-84, the flammability characteristics of UL 94 V0 and the self-extinguishing requirements of ASTM D635. (Polyester resin is available without flame retardant and UV inhibitor additives.)

E. After fabrication, all cut ends, holes and abrasions of FRP shapes shall be sealed with a compatible resin coating.

F. FRP products exposed to weather shall contain an ultraviolet inhibitor. Should additional ultraviolet protection be required, a UV coating can be applied.

G. Manufacturers:
   1. Strongwell
   2. Or Equal

H. The materials covered by these specifications shall be furnished by an ISO-9001 certified manufacturer.

2.2 PULTRUDED GRATINGS AND TREADS:

A. General
   1. Grating shall be shipped from the manufacturer, palletized and banded with exposed edges protected to prevent damage in shipment.
   2. Each piece shall be clearly marked showing manufacturer's applicable drawing number.

B. Design
   1. Walkway and platform grating panels shall be 2 inches deep.
   2. The bearing bars shall be joined into panels by passing continuous length fiberglass pultruded cross rods through the web of each bearing bar. A continuous fiberglass pultruded bar shaped section shall be wedged between the two cross rod spacers mechanically locking the notches in the cross rod spacers to the web of the bearing bars. Continuous adhesive bonding shall be achieved between the cross rod spacers and the bearing web and between the bar shaped wedge and the two cross rod spacers locking the entire panel together to give a panel that resists twist and prevents internal movement of the bearing bars. Each stair tread shall utilize a box-shaped nosing on its lead edge to enclose cross rods and ensure a smooth vertical edge.
   3. The top surface of all panels shall have a non-skid grit affixed to the surface by an epoxy resin followed by a baked-on top coat of epoxy resin.
   4. Surface should have a Wear Index of less than 1.0 when tested to ASTM D4060 (Before and after 750 hours of UV exposure per ASTM D4329 cycle A).
   5. Panels shall be fabricated to the sizes shown on the drawings.
   6. Hold down clamps shall be type 316L stainless steel clips. Use 2 at each support with a minimum of 4 per panel.
   7. Color shall be as match existing as closely as possible or as selected by Owner, chosen from manufacturer's standard colors.
   8. All bearing bars that are to be exposed to UV shall be coated with polyurethane coating to provide additional UV protection.

C. Products

   1. The Pultruded FRP grating and stair treads shall be fabricated from bearing bars and cross

rods manufactured by the pultrusion process. The glass fiber reinforcement for the bearing bars shall be a core of continuous glass strand rovings wrapped with continuous strand glass mat. With the exception of grating and stair treads manufactured using phenolic resin, a synthetic surface veil fabric shall encase the glass reinforcement.

2. Fiberglass Grating and Stair Treads
   a. Fiberglass grating and stair treads shall be made from a chemical resistant, fire retardant polyester, vinyl ester or phenolic resin system to meet the flame spread rating of 25 or less in accordance with ASTM E-84 testing, the flammability characteristics of UL 94 V0 and satisfies the self-extinguishing requirements of ASTM D-635. UV inhibitors are added to the resin to reduce UV attack.
3. If required, all cut and machined edges, holes and abrasions shall be sealed with a resin or compatible coating with the resin matrix used in the bearing bars and cross rods.
4. All panels shall be fabricated to the sizes shown on the approved shop drawings.

PART 3 - EXECUTION

3.1 PREPARATION:

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.

B. Coordinate delivery of such items to project site.

3.2 INSPECTION AND TESTING:

A. The Design Engineer shall have the right to inspect and test all materials to be furnished under these specifications prior to their shipment from the point of manufacture.

B. All labor, power, materials, equipment and appurtenances required for testing shall be furnished by the Contractor at no cost to the Owner.

3.3 INSTALLATION, GENERAL:

A. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts and other connectors as determined by the Design Engineer.

B. Cutting, fitting and placement: Perform cutting, drilling and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment and elevation; with edges and surfaces level, plumb, true and free of rack; measured from established lines and levels.

C. Provide temporary bracing or anchors in form work for items that are to be built into concrete masonry or similar construction.

D. Penetrations through grating may require additional supports in order to meet design criteria. The Contractor shall follow manufacturer recommendations for each occurrence.

3.4 ALL FRP INSTALLATION:

A. If required, all field cut and drilled edges, holes and abrasions shall be sealed with a catalyzed resin compatible with the original resin as recommended by the manufacturer.

B. Install items specified as indicated and in accordance with manufacturer instructions.

END OF SECTION

SECTION 071400 - FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide and apply single-component, fluid-applied liquid waterproofing system to below grade concrete slabs, walls, and footings of non-hydraulic (liquid-retaining) structures including surface preparation.

1.2 RELATED SECTIONS

A. Section 033000 Cast-in-Place Concrete

B. Section 079200 - Joint Sealants.

1.3 REFERENCES

A. ASTM International (ASTM) standards, most recent editions:

ASTM C836	Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
ASTM D41	Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
ASTM D1644	Standard Test Methods for Nonvolatile Content of Varnishes
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials

1.4 SUBMITTALS

A. Submit in accordance with Section 013300 – Contractor Submittals.

B. Product Data: For each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

C. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions which may be required.

D. Qualification Data: For qualified Installer.

E. Product Test Reports: For waterproofing, based on evaluation of comprehensive tests performed by a qualified testing agency.

F. Field quality-control reports.

G. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that is approved or licensed by manufacturer for installation of waterproofing required for this Project and is eligible to receive special warranties specified.

B. Source Limitations: Obtain waterproofing materials from single source from single manufacturer.

C. Preinstallation Conference: Conduct conference at Project site.
   1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, installation procedures, testing and inspection procedures, and protection and repairs.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 016100 – Product Requirements.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer.

C. Remove and replace liquid materials that cannot be applied within their stated shelf life.

D. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below 0 Degrees F.
   1. Do not apply membrane when air, material, or surface temperatures are expected to fall below 30 Degrees F within four hours of completed application.
   2. Do not apply membrane if rainfall is forecast or imminent within 12 hours.
   3. Do not apply waterproofing membrane to any surfaces containing frost.
   4. Consult manufacturer for applications to green concrete.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.8 WARRANTY

A. Special Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents, and shall be in addition to, and run concurrent with, other warranties made under requirements of the Contract Documents.

B. Provide written warranty signed by waterproofing manufacturer and installer agreeing to repair or replace waterproofing that does not meet requirements or that does not remain watertight within the specified warranty period.

C. Warranty Period: 3 years after date of Substantial Completion.

D. Warranty does not include failure of waterproofing due to failure of substrate or formation of new joints and cracks in substrate that exceed 1/16 inch in width.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers and products are acceptable:
   1. Fluid Applied Waterproofing:
      a. Epro Services, Inc., Ecobase Waterproofing Membrane.
      b. Tremco Barrier Solutions, Tuff-N-Dri H8 Waterproofing.
      c. Engineer approved equal.

2.2 PERFORMANCE CRITERIA

A. Waterproofing Membrane:
   1. Single-component, polymer-enhanced liquid-applied membrane with the following minimum properties:
      a. Solids content, ASTM D1644, 60% minimum.
      b. Tensile Strength, ASTM D412: 15 psi, minimum.
      c. Elongation, ASTM D412: 1100%, minimum.
      d. Water Vapor Transmission, ASTM E96: 1 perms maximum (40 mil dry coat).
      e. Hydrostatic Pressure Resistance, 8 feet water head, minimum.
      f. Adhesion, ASTM C836, minimum 11 lb/inch to peel from concrete and masonry.

B. Sealants and Accessories: Manufacturer's recommended sealants and accessories.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
   2. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

E. Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

3.3 JOINTS, CRACKS, AND TERMINATIONS

A. Prepare and treat substrates to receive waterproofing membrane, including expansion joints, construction joints, cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.

3.4 MEMBRANE APPLICATION

A. Apply using appropriate equipment and nozzles, per manufacturer’s recommendations. Start application with manufacturer's authorized representative present.

B. Membrane: Spray apply asphalt emulsion membrane to substrates and adjoining surfaces indicated. Spread to a minimum wet thickness per manufacturer’s specification to achieve listed hydrostatic resistance, minimum of 60 mils.

C. Apply waterproofing over prepared joints and up wall terminations and vertical surfaces to heights indicated or required by manufacturer.

D. Allow product to cure prior to backfilling.

E. When buried surfaces that have been waterproofed are not backfilled within 30 days of membrane applications, membrane shall be coated with whitewash. Any formula for mixing the whitewash may be used which is not detrimental to the membrane and produces a uniformly coated white surface which remains until backfill is placed.

3.5 FIELD QUALITY CONTROL

A. Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions; surface preparation; and application of the membrane, flashings, protection, and drainage components; furnish daily reports to Engineer.

3.6 CLEANING AND PROTECTION

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071400

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Glass – Fiber Blanket Insulation
   2. Spray polyurethane foam insulation.
   3. Polystyrene rigid foam insulation.
   4. Vapor retarders.
   5. Insulation Fasteners

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Research/evaluation reports.

1.4 QUALITY ASSURANCE

A. Thermal Resistivity: Where thermal resistivity properties of insulation materials are designated by r-values they represent the rate of heat flow through a homogenous material exactly 1" thick, measured by test method included in referenced material standard or otherwise indicated. They are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.

B. Fire Performance Characteristics: Provide insulation materials which are identical to those whose fire performance characteristics, as listed for each material or assembly of which insulation is a part, have been determined by testing, per methods indicated below, by UL or other testing and inspecting agency acceptable to authorities having jurisdiction.

C. Surface Burning Characteristics: ASTM E 84.

D. Fire Resistance Ratings: ASTM E 119.

E. Combustion Characteristics: ASTM E 136.

F. Maximum Allowable Asbestos Content of Inorganic Insulations: Provide insulations composed of mineral fibers or mineral ores which contain less than 0.25% by weight of asbestos of nay

type or mixture of types occurring naturally as impurities as determined by polarized light microscopy test per Appendix A of 40 CFR 763.

1.5 DELIVERY, STORAGE AND HANDLING

A. General Protection: Protect insulation from physical damage and from becoming wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation.

B. Protection for Plastic Insulation:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver plastic insulating materials to project site ahead of installation time.
3. Complete installation and concealment of plastic materials as rapidly as possible in each area of work.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CertainTeed Corporation.
2. Owens Corning.
3. Or Equal.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

C. Polypropylene-Scrim-Kraft-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type II (non-reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).

D. Kraft-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type II (non-reflective faced), Class C (faced surface not rated for flame propagation); Category 1 (membrane is a vapor barrier).

E. Reinforced-Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

F. Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class B (faced surface with a flame-propagation resistance of 0.12 W/sq. cm); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

G. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves.

2.2 SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Minimum density of 1.5 lb/cu. ft., thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.

B. Acrylic Elastomer Coating: ASTM D6083, with resistance to accelerated weathering and wind driven rain. The coating shall withstand a loading of 29 psi with no tearing, cracking, rupturing or permanent deformation. Coating shall be United Coatings, Diathon or equal. Coating shall be white.

2.3 EXTRUDED POLYSTYRENE RIGID FOAM INSULATION

A. Closed-cell polystyrene insulation shall be moisture resistant rigid foam board and shall be suitable for installation between concrete and soil.

B. Insulative properties: R-5 per inch.

2.4 VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D 4397, 10 mils thick, with maximum permeance rating of 0.13 perm.

B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.5 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation, of thickness indicated, securely in position indicated with self-locking washer in place; and complying with the following requirements:

1. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch thick by 2 inches (50 mm) square.

2. Spindle: Copper-coated low carbon steel, fully annealed, 0.105 inches in diameter, length to suit depth of insulation indicated.

A. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Where spindles will be exposed to human contact after installation, protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap.

B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.

C. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1. Adhesively Attached, Spindle-Type Anchors:
      a. TACTOO Insul-Hangers; AGM Industries, Inc.
      b. Spindle Type Gemco Hangers; Gemco.
   2. Anchor Adhesives:
      a. TACTOO Adhesive; AGM Industries, Inc.
      b. Tuff Bond Hanger Adhesive; Gemco.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.2 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

   1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose.

3.3 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Glass-Fiber: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
6. For wood-framed construction, install blankets according to ASTM C 1320 and as follows:
    a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.

7. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.

    a. Exterior Walls: Set units with facing placed as indicated on Drawings.
    b. Interior Walls: Set units with facing placed as indicated on Drawings.

C. Spray-Applied Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

D. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.4 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

A. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to

insulation manufacturer's written instructions for insulation type, thickness, and application indicated.

2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.
5. The spindles shall be spaced at 16” on center, or as indicated on the drawings.

3.5 INSTALLATION OF SPRAY POLYURETHANE FOAM INSULATION

A. Place insulation following required primer or surface preparation. Install insulation according to manufacturer's written instructions applicable to products and applications indicated.

1. Place acrylic elastomer coating according to manufacturer's written instructions applicable to products and applications indicated.

3.6 INSTALLATION OF VAPOR RETARDERS

A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.

1. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches o.c.
2. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
3. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.

C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

END OF SECTION 072100

SECTION 074213 - METAL WALL PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Uninsulated single-skin concealed fastener metal wall panel system.

1.2 RELATED SECTIONS

A. Section 072100 - Thermal Insulation.

B. Section 076200 - Sheet Metal Flashing and Trim.

C. Section 079020 - Joint Sealants.

D. Section 091110 – Non Load Bearing Steel Framing

E. Section 092900 - Gypsum Board.

1.3 REFERENCES

A. American Architectural Manufacturer's Association (AAMA):
   1. AAMA 501.1 - Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure.
   2. AAMA 508- Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems
   3. AAMA 620 - Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Aluminum Substrates.
   4. AAMA 621 - Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
   5. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. ASTM International (ASTM):
   1. ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. ASTM A 755/A 755M - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
   3. ASTM B 209 - Specification for Aluminum and Aluminum Alloy Sheet and Plate.
   4. ASTM B 221 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   5. ASTM C 236 - Standard Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.
   6. ASTM C 754 - Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products.

7. ASTM C 920 - Specification for Elastomeric Joint Sealants.
8. ASTM C 1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
9. ASTM D 3359 - Standard Test Methods for Measuring Adhesion by Tape Tests.
10. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
11. ASTM E 112 - Standard Test Method for Determining Average Grain Size.
12. ASTM E 283 - Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
13. ASTM E 329 - Standard Specification for Agencies Engaged in Construction Inspection. ASTM E 283 - Test Method for Determin. ASTM E 283 - Test Method for Determinand/or Testing.
14. ASTM E331 - Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

C. American Iron and Steel Institute (AISI):
1. Specification for the Design of Cold-Formed Steel Structural Members.

D. American Institute of Steel Construction (AISC):
1. Code of Standard Practice.

E. American Society of Civil Engineers (ASCE):
1. ASCE-7, Minimum Design Loads for Buildings and Other Structures.

F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):
1. Architectural Sheet Metal Manual.

1.4 SUBMITTALS

A. Submit product data, test reports, and certifications in accordance with quality assurance and performance requirements specified herein.

B. Submit panel shop drawings consisting of design and erection drawings, finish specifications, and other data necessary to clearly describe the design, materials, sizes, layouts, construction details, and erection. Submit small-scale layouts of panels and large-scale details of edge conditions, joints, fastener and sealant placement, flashings, penetrations, and special details. Distinction must be made between factory and field assembled work.
1. Drawings shall be approved prior to fabrication.

C. Material Samples:
1. Panels: One of each type, full panel width by 12 inches (305 mm) long.
2. Fasteners: Two of each type with statement of intended use.
3. Closures: One of each type metal closure and foam closure as required.
4. Sealants: One sample of each type with statement of intended use.
5. Clips: Two of each type.

D. Selection Samples for Color: For each finish product specified, furnish two color chip samples selected from the manufacturer's full range of available colors and patterns.

E. Verification Samples for Color: For each finish product specified, two samples, minimum size 6 square inches (150 mm), representing actual product, color, and patterns.

F. Qualification Information: For Installer firm, proof of installer's manufacturer trained field supervisor.

G. Warranty: Submit proposed warranty meeting requirements of this Section.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The manufacturer shall have had a minimum of ten years experience in the successful completion of projects employing similar materials, applications, and performance requirements.
   1. Manufacturer shall provide a list of five similar completed projects with addresses of the project location, architect, and owner.

B. Installer Qualifications: The wall systems contractor shall have had a minimum of ten years experience in the successful completion of projects employing similar materials, applications, and performance requirements.
   1. The wall systems contractor shall provide a list of five similar completed projects with addresses of the project location, architect, and owner.

C. Dade Country Approval, Miami-Dade County Notice of Acceptance (NOA).

D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish areas designated by Architect.
   2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
   3. Refinish mock-up area as required to produce acceptable work.

E. Pre-installation Conference: Conduct conference at Project site in compliance with Division 01 requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be unloaded and stored per the manufacturer's instructions to prevent damage due to handling and weather.

1.7 PROJECT CONDITIONS

A. It is the panel installers responsibility to verify locations of structural members, adjoining construction and wall openings dimensions by field measurement before panel fabrication and indicate measurements on final shop drawings.

1.8 WARRANTY

A. Material Warranty: The manufacturer shall warrant that the materials and accessories furnished in accordance with these specifications shall remain free from defects in material and factory workmanship for a period of two years from date of shipment.

B. Paint Finish Warranty: The manufacturer shall warrant against fading, chalking, peeling, cracking, checking, chipping, or erosion to base metal of the exterior panel finish, in accordance with the paint supplier's standards.
   1. Warranty Period: 20 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: CENTRIA Architectural Systems

B. Substitutions: Requests for substitutions will be considered in accordance with provisions of Section 016000 - Product Requirements. Evidence shall be submitted to demonstrate equivalency to the products and performance levels specified. The written request shall include:
   1. A complete description of the substitution, including details of all transition conditions at panel termination points.
   2. Independent test reports verifying compliance with the performance requirements.
   3. A detailed list of each item that does not fully comply with the specifications.
   4. A letter stating that the manufacturer or wall systems contractor proposing the substitution will pay additional costs incurred by subcontractors affected by the proposed substitution.

2.2 CONCEALED FASTENER METAL WALL PANELS

A. System Description:
   1. Metal Wall Panels over Multi-Component Framed Wall System: Single-skin concealed fastener metal wall panels applied as interior cladding. Wall framing indicated with interior sheathing and framing specified in other specification section. Applied membrane that provides air, moisture, and water vapor control in other specification section. Insulation within the framing specified in other specification.

B. Metal Wall Panels, General: Factory-formed, concealed fastener panels with interconnecting side joints, fastened to supports with concealed fasteners, with factory-applied sealant in side laps when required to meet performance requirements.

C. System Performance Requirements: Provide metal wall panel assemblies meeting performance requirements as determined by application of specified tests by a qualified testing agency on manufacturer's standard assemblies.
   1. Air Infiltration: Maximum 0.06 cfm/sq. ft. (0.3 L/s per sq. m) per ASTM E 283 at a static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa), using minimum 10-by-10 foot (3050-by-3050 mm) test panel that includes side joints.
   2. Water Penetration, Static Pressure: No uncontrolled water penetration per ASTM E 331 at a minimum static differential pressure of 6.24 lbf/sq. ft. (299 Pa), using minimum 10-by-10 foot (3050-by-3050 mm) test panel that includes side joints.
      a. Limits of Deflection: Metal wall panel assembly shall withstand scheduled wind pressure with the following allowable deflection:
         1) Maximum allowable deflection limited to L/180 deflection of panel perimeter normal to plane of wall with no evidence of failure.
   3. Thermal Movements: Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by

2.3 LINER PANELS

A. Metal Liner Panels, General: Factory-formed panels with interconnecting side joints, fastened to supports with fasteners.
   1. Material: Zinc-Coated (Galvanized) Steel Sheet.
   2. Face Sheet: Minimum 0.036 inch/20 gage (0.91 mm) nominal uncoated thickness.
   3. Panel Sheet: Solid.

4. Surface: Smooth.

B. Metal liner panel:
   1. Basis of Design Product: CENTRIA, L2.
   2. Panel Coverage: 24 inches (610 mm).
   3. Panel Height: 1-3/8 inches (35 mm).
   4. Stiffening Beads: Two.
   5. Fluoropolymer Two-Coat Corrosion and Abrasion Resistant System: 3.0 mil epoxy-modified primer with 0.8 mil 70 percent PVDF fluoropolymer color coat
      a. Basis of Design: CENTRIA Versacor Ultra PF.

C. Color:
   1. Interior Exposed Surface: As selected by Architect from manufacturer's standard colors.

2.4 METAL WALL PANEL ACCESSORIES

A. Metal Wall Panel Backup System: Refer to related specification section for requirements,

B. Metal Wall Panel Accessories, General: Provide complete metal wall panel assembly incorporating trim, copings, fasciae, parapet caps, soffits, sills, inside and outside corners, and miscellaneous flashings. Provide manufacturer's factory-formed clips, shims, flashings, gaskets, lap tapes, closure strips, and caps for a complete installation. Fabricate and install accessories in accordance with SMACNA Manual.

C. Extruded Trim: Manufacturer's complementary aluminum extrusions for head, jamb, sill, base, flush, reveal, inside and outside corner, endwall, and expansion joint details. Finish to match metal wall panels.
   1. Basis of Design: CENTRIA, Microline Extrusions.

D. Mitered Corners: Structurally-bonded horizontal interior and exterior trimless corners matching metal wall panel material, profile, and factory-applied finish, fabricated and finished by metal wall panel manufacturer.
   1. Welded, riveted, fastened, or field- fabricated corners do not meet the requirements of this specification.
   2. Basis of Design: CENTRIA, MicroSeam Corners.

E. Formed Flashing and Trim: Match material, thickness, and color of metal wall panel face sheets.

F. Sealants: Type recommended by metal wall panel manufacturer for application, meeting requirements of Joint Sealants section.

G. Flashing Tape: 4 inches (102 mm) wide self-adhering butyl flashing tape.

H. Fasteners, General: Self-tapping screws, bolts, nuts, and other acceptable fasteners recommended by panel manufacturer. Where exposed fasteners cannot be avoided for miscellaneous applications, supply corrosion-resistant fasteners with heads matching color of metal wall panels by means factory-applied coating.

I. Concealed Clips: Galvanized steel, 0.051 inch/16 gauge (1.3 mm) thick, designed to allow unimpeded thermal movement of panel and configured to hold panel minimum 1/2 inch (13 mm) from substrate.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine wall panel substrate with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of metal wall panels.

B. Wall Substrate: Confirm that wall substrate is within tolerances acceptable to metal wall panel system manufacturer.
   1. Maximum substrate and framing deviations from flat plane acceptable:
      a. 1/4-inch in 20 feet (6 mm in 6 m) vertically or horizontally.
      b. 1/2-inch (13 mm) across building elevation.
      c. 1/8-inch in 5 feet (3 mm in 1.5 m).

C. Framing: Inspect framing that will support metal wall panels to determine if support components are installed as indicated on approved shop drawings. Confirm presence of acceptable framing members at recommended spacing to match installation requirements of metal wall panels.

D. Air/Moisture Barriers: Confirm that work has been completed, inspected, and tested as required.

E. Openings: Verify that window, door, louver and other penetrations match layout on shop drawings.

F. Correct out-of-tolerance work and other deficient conditions prior to proceeding with metal wall panel system installation.

3.2 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in accordance with approved shop drawings and manufacturer's recommendations. Install metal wall panels in orientation, sizes, and locations indicated. Anchor metal wall panels and other components securely in place. Provide for thermal and structural movement:
   1. Insulated-Composite Metal Wall Backup Panels: Install in accordance with requirements of related section for Insulated-Composite Metal Wall Backup Panels.

B. Attach panels to metal framing using recommended clips, screws, fasteners, sealants, and adhesives indicated on approved shop drawings.
   1. Fasteners for Steel Wall Panels: Stainless-steel for exterior locations and locations exposed to moisture; carbon steel for interior use only.
   2. Fasten metal wall panels to supports with concealed clips at each joint at location, spacing, and with fasteners recommended by manufacturer. Install clips to supports with self-tapping fasteners.
   3. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
   4. Dissimilar Materials: Where elements of metal wall panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.

C. Joint Sealers: Install joint sealants where indicated on approved shop drawings.

3.3 ACCESSORY INSTALLATION

A. General: Install metal wall panel accessories with positive anchorage to building and provide for thermal expansion. Coordinate installation with flashings and other components.
   1. Install related flashings and sheet metal trim per requirements of section Sheet Metal Flashing and Trim.
   2. Install components required for a complete metal wall panel assembly, including trim, copings, corners, lap strips, flashings, sealants, fillers, closure strips, and similar items.
   3. Comply with performance requirements and manufacturer's written installation instructions.
   4. Provide concealed fasteners except where noted on approved shop drawings.
   5. Set units true to line and level as indicated.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a service representative authorized by metal wall panel manufacturer to inspect completed installation. Submit written report.

B. Correct deficiencies noted in manufacturer's report.

3.5 CLEANING AND PROTECTION

A. Remove temporary protective films. Clean finished surfaces as recommended by metal wall panel manufacturer. Clear weep holes and drainage channels of obstructions, dirt, and sealant. Maintain in a clean condition during construction.

B. Replace damaged panels and accessories that cannot be repaired by finish touch-up or minor repair.

END OF SECTION 074213

SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Adhered thermoplastic polyolefin (TPO) roofing system.
   2. Roof insulation.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Roofing Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. Research/Evaluation Reports: For components of roofing system, from ICC-ES.

B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Firestone Building Products.
2. Versico Incorporated.
3. Or equal.

2.2 PERFORMANCE REQUIREMENTS

A. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.

B. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.

C. Energy Performance: Roofing system shall have an initial solar reflectance index of not less than **0.70** and an emissivity of not less than **0.75** when tested according to CRRC-1.

D. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.3 TPO ROOFING

A. Fabric-Reinforced TPO Sheet: ASTM D 6878, internally fabric- or scrim-reinforced, uniform, flexible TPO sheet.

1. Thickness: 60 mil.
2. Exposed Face Color: White.

2.4 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils thick, minimum, of same color as TPO sheet.

C. Slip Sheet: Manufacturer's standard, of thickness required for application.

D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.

E. Miscellaneous Accessories: Provide metal termination bars, metal battens, pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

F. Walkways: Walkway materials shall be Heat weldable material provided/recommended by the roofing system manufacturer. Walkways shall be 180 mils thick (nominal) with diamond plate tread pattern for slip resistance. Walkways shall be gray with safety yellow at edges.

2.5 POLYISOCYANURATE FOAM BOARD INSULATION

A. Polyisocyanurate Insulation: ASTM C 1289. Type II, Class 1, Grade 3, felt or glass-fiber mat facer on both major surfaces. Board size shall not exceed 4’ x 8’ for mechanically attached and 4’ x 4’ for adhered to a substrate.

B. Minimum R value shall be 5.6 per inch. Boards shall be no thicker than 2”. Multiple boards shall be used to meet the insulation requirements on the drawings, if necessary. The topmost layer of board shall be staggered vertically and offset from the joints in the underlying layers.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to:
   a. Firestone Building Products

2.6 INSULATION ACCESSORIES

A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer.

C. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

PART 3 - EXECUTION

3.1 ROOFING INSTALLATION, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions.

B. Prepare existing roof substrate according to system manufacturer’s recommendations and requirements prior to application of new roof system

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

D. Install roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing roofing system.

3.2 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Install tapered insulation under area of roofing to conform to slopes indicated.

C. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

1. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

D. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:

1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft., and allow primer to dry.
2. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
3. Set each layer of insulation in insulation adhesive, firmly pressing and maintaining insulation in place.
4. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
5. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
6. Set each subsequent layer of insulation in insulation adhesive, firmly pressing and maintaining insulation in place.

E. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together.

1. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

F. Install slip sheet over cover board and immediately beneath roofing.

3.3 ADHERED ROOFING INSTALLATION

A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.

B. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

C. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.

D. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.

E. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

F. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.4 INSTALLATION

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings.

3.5 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075423

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following sheet metal flashing and trim:
   1. Manufactured reglets.
   2. Formed roof drainage system.
   3. Formed low-slope roof flashing and trim.
   4. Formed wall flashing and trim.
   5. Formed equipment support flashing.

B. Related Sections include the following:
   1. Division 6 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
   2. Division 13 Section "Pre-Engineered Metal Buildings" for factory-formed metal roof panels and flashing and trim not part of sheet metal flashing and trim.
   3. Division 8 Section "Unit Skylights".
   4. Division 7 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

1.3 PERFORMANCE REQUIREMENTS

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
   1. Wind Zone 1: For velocity pressures of 21 to 30 lbf/sq. ft. (1.00 to 1.44 kPa): 60-lbf/sq. ft. (2.87-kPa) perimeter uplift force, 90-lbf/sq. ft. (4.31-kPa) corner uplift force, and 30-lbf/sq. ft. (1.44-kPa) outward force.

C. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Include the following:
1. Identify material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
4. Details of expansion-joint covers, including showing direction of expansion and contraction.

C. Samples for Selection: For each type of sheet metal flashing and trim indicated with factory-applied color finishes.
1. Include similar Samples of trim and accessories involving color selection.

1.5 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

B. Mockups: Prior to installing sheet metal flashing and trim, construct mockups indicated to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final unit of Work.
1. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Engineer.
2. Notify Engineer one week in advance of the dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Construct mockups for the following type of sheet metal flashing and trim:
   a. Exposed trim, gravel stops, and fasciae.
   b. Copings.
5. Obtain Architect's approval of mockups before start of final unit of Work.
6. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   a. When directed, demolish and remove mockups from Project site.
   b. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
2. Review methods and procedures related to sheet metal flashing and trim.
3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.7 COORDINATION

A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 SHEET METALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality, mill phosphatized for field painting.

B. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.

2. Exposed Finishes: Apply the following coil coating:
   a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Fluoropolymer 3-Coat System: Manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a minimum total dry film thickness of 1.5 mil (0.038 mm); complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:
         a) Humidity Resistance: 2000 hours.
         b) Salt-Spray Resistance: 2000 hours.
      2) Color: Custom color as selected by Engineer/Architect from manufacturer's full range, to match existing, including deep tone colors.

C. Lead Sheet: ASTM B 749, Type L51121, copper-bearing lead sheet.

D. Zinc Sheet: Electrolytic, 99 percent pure zinc alloyed with 1 percent titanium and copper.
   1. Finish: Bright rolled.

2.3 UNDERLAYMENT MATERIALS

A. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.

B. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
   1. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory-applied coating.
   2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
   3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
   4. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

C. Solder for Lead: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

D. Solder for Zinc: ASTM B 32, 60 percent lead and 40 percent tin with low antimony, as recommended by manufacturer.

E. Burning Rod for Lead: Same composition as lead sheet.

F. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

G. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

H. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 MANUFACTURED SHEET METAL FLASHING AND TRIM

A. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory- mitered and -welded corners and junctions.
   1. Available Manufacturers:
      a. Fry Reglet Corporation.
   2. Material: Galvanized steel, 0.0217 inch (0.55 mm) thick.
   3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   4. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
      a. Available Manufacturers:
         1) Cheney Flashing Company, Inc., Type B Snap Lock.
   5. Flexible Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
   6. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

2.6 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.

B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
   1. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

D. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

E. Seams: Comply with SMACNA AArchitectural Sheet Metal Manual@, (Sixth Edition, September 2003) Figure no. 3-2 and 3-3 as applicable to specific installations.
   1. Standing Seams: Provide double lock standing seams (detail no. 25, figure no. 3-3), with finish not less than 1-1/4" high.

F. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with elastomeric sealant concealed within joints.

G. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

H. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
   1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

2.7 ROOF DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
   1. Gutter Style: D and as detailed.
   2. Expansion Joints: Built in.
   3. Accessories: Continuous removable leaf screen with sheet metal frame and hardware cloth screen.
   4. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following material:
      a. Prepainted, Metallic-Coated Steel: 0.0299 inch (0.76 mm) thick.

B. Downspouts: Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
   1. Fabricate downspouts from the following material:
      a. Prepainted, Metallic-Coated Steel: 0.0299 inch (0.76 mm) thick.

2.8 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.
   1. Joint Style: Standing seams.
   2. Fabricate copings from the following material:
      a. Prepainted, Metallic-Coated Steel: 0.0396 inch (1.0 mm) thick.

B. Roof and Roof to Wall Transition Expansion-Joint Cover: Fabricate from the following material:
   1. Prepainted, Metallic-Coated Steel: 0.0336 inch (0.85 mm) thick.

C. Base Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0276 inch (0.7 mm) thick.

D. Counterflashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0217 inch (0.55 mm) thick.

E. Flashing Receivers: Fabricate from the following material:
   1. Galvanized Steel: 0.0217 inch (0.55 mm) thick.

F. Roof-Penetration Flashing: Fabricate from the following material:
   1. Galvanized Steel: 0.0276 inch (0.7 mm) thick.

2.9 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12 foot (3.6 m) long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings. Form with 2-inch- (50-mm-) high end dams. Fabricate from the following material:
   1. Zinc: 0.040 inch (1.0 mm) thick.

B. Openings Flashing in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high end dams. Fabricate from the following material:
   1. Prepainted, Metallic-Coated Steel: 0.0217 inch (0.55 mm) thick.

C. Wall Expansion-Joint Cover: Fabricate from the following material:
   1. Prepainted, Metallic-Coated Steel: 0.0276 inch (0.7 mm) thick.

2.10 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following material:

1. Galvanized Steel: 0.0276 inch (0.7 mm) thick.

2.11 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
1. Coat side of sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.

C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.

D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.

E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
   1. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with elastomeric sealant concealed within joints.

G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
   1. Galvanized or Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.

H. Seal joints with elastomeric sealant as required for watertight construction.
   1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
   2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm) except where pretinned surface would show in finished Work.
   1. Do not solder prepainted, metallic-coated steel sheet.
   2. Pretinning is not required for lead.
   3. Where surfaces to be soldered are lead coated, do not tin edges, but wire brush lead coating before soldering.
   4. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

3.3 ROOF DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with elastomeric sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets spaced not more than 36 inches (900 mm) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.
   1. Fasten gutter spacers to front and back of gutter.
   2. Loosely lock straps to front gutter bead and anchor to roof deck.
   3. Anchor and loosely lock back edge of gutter to continuous eave or apron flashing.
   4. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
   5. Anchor gutter with spikes and ferrules spaced not more than 24 inches (600 mm) apart.
   6. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.24 m) apart. Install expansion joint caps.
   7. Install continuous gutter screens on gutters with noncorrosive fasteners, hinged to swing open for cleaning gutters.

C. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.
   1. Provide elbows at base of downspout to direct water away from building or connect downspouts to underground drainage system indicated.

3.4 ROOF FLASHING INSTALLATION

A. General: Install sheet metal roof flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
   1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 16-inch (400-mm) centers.

C. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
   1. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 16-inch (400-mm) centers.
   2. Anchor interior leg of coping with screw fasteners and washers at 18-inch (450-mm) centers.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with elastomeric sealant.
   1. Secure in a waterproof manner by means of snap-in installation and sealant.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:
   1. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.5 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Through-Wall Flashing: Installation of formed through-wall flashing is specified in Division 4 Section "Unit Masonry Assemblies."

C. Reglets: Installation of reglets is specified in Division 3 Section "Cast-in-Place Concrete”

D. Openings Flashing in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

3.6 MISCELLANEOUS FLASHING INSTALLATION

A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.7 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

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SECTION 078410 – THROUGH PENETRATION FIRE STOP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1. The work of this section shall include, but not be limited to, all clips and other restraining devices necessary for holding fire protection material in place and other items necessary for a complete and integral installation thru out the entire perimeter and other penetrations.

B. Related Sections include the following:

1. Division 22 and 23 Sections specifying duct and piping penetrations.
2. Division 26 Sections specifying cable and conduit penetrations.

1.3 PERFORMANCE REQUIREMENTS

A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

1. Fire-resistance-rated walls including fire walls, fire partitions, fire barriers, and smoke barriers.
2. Fire-resistance-rated horizontal assemblies including floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.

B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:

1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
3. Penetrations located outside wall cavities.
4. Penetrations located outside fire-resistance-rated shaft enclosures.

5. L-Rated Systems: Where through-penetration firestop systems are indicated in smoke barriers, provide through-penetration firestop systems with L-ratings of not more than 3.0 cfm/sq. ft (0.01524cu. m/s x sq. m) at both ambient temperatures and 400 deg F (204 deg C).

C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items. Retain subparagraph below only after verifying that authorities having jurisdiction will accept modifications handled by method in subparagraph.

C. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:

1. Types of penetrating items.
2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.

D. Qualification Data: For Installer.

E. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."

B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.

C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:

1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems complying with the following requirements:
    a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
    b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
        1) UL in its "Fire Resistance Directory."

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's inspecting agency and building inspector, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, through-penetration firestop systems that may be incorporated into the Work include, but are not limited to, those systems indicated that are produced by one of the following manufacturers:

1. Grace, W. R. & Co. - Conn.
2. Hilti, Inc.
3. Nelson Firestop Products.
4. 3M; Fire Protection Products Division.
5. Tremco; Sealant/Weatherproofing Division.

2.2 FIRESTOPPING, GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:
    a. Slag-/rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.
2. Temporary forming materials.

3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

A. General: Provide through-penetration firestop systems containing the types of fill materials indicated. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.

B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

E. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

F. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.

G. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

H. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Include the following information on labels:

1. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Through-penetration firestop system designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop system manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified, independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.

B. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION 078410

SECTION 079200 - JOINT SEALANTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
   1. Exterior joints in the following vertical surfaces and horizontal nontraffic surfaces:
      a. Construction joints in cast-in-place concrete.
      b. Control and expansion joints in unit masonry and cast stone units.
      c. Joints between metal panels.
      d. Joints between different materials listed above.
      e. Perimeter joints between materials listed above and frames of doors and windows.
      f. Control and expansion joints in ceilings and other overhead surfaces.
      g. Other joints as indicated.
   2. Exterior joints in the following horizontal traffic surfaces:
      a. Isolation and contraction joints in cast-in-place concrete slabs.
      b. Tile control and expansion joints.
      c. Joints between different materials listed above.
      d. Other joints as indicated.
   3. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
      a. Control and expansion joints on exposed interior surfaces of exterior walls.
      b. Perimeter joints of exterior openings where indicated.
      c. Tile control and expansion joints.
      d. Vertical joints on exposed surfaces of walls and partitions.
      e. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
      f. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      g. Other joints as indicated.
   4. Interior joints in the following horizontal traffic surfaces:
      a. Isolation joints in cast-in-place concrete slabs.
      b. Control and expansion joints in tile flooring.
      c. Other joints as indicated.

B. Related Sections include the following:
   1. Division 8 Section "Glazing" for glazing sealants.
   2. Division 9 Section "Gypsum Board Assemblies" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.
   3. Division 9 Section "Tiling" for sealing tile joints.

1.3 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

D. Qualification Data: For Installer.

E. Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.

F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

G. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
   1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each application indicated below:
   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of nonelastomeric sealant and joint substrate indicated.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.
   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

E. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:
1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

B. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
   1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
   2. Disintegration of joint substrates from natural causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Immersion in Liquids. Where elastomeric sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247 and qualify for the length of exposure indicated by

reference to ASTM C 920 for Class 1 or 2. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

E. Single-Component Neutral-Curing Silicone Sealant:
   1. Available Products:
      a. Pecora Corporation; 895.
   2. Type and Grade: S (single component) and NS (nonsag).
   3. Class: 50.
   4. Use Related to Exposure: NT (nontraffic).
   5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
      a. Use O Joint Substrates: Aluminum coated with a high-performance coating.
   6. Stain-Test-Response Characteristics: Nonstaining to porous substrates per ASTM C 1248.

F. Single-Component Acid-Curing Silicone Sealant:
   1. Available Products:
      a. Dow Corning Corporation; 999-A.
      b. GE Silicones; Construction
      c. Pecora Corporation; 860.
      d. Tremco; Proglaze.
   2. Type and Grade: S (single component) and NS (nonsag).
   3. Class: 25.
   4. Use Related to Exposure: NT (nontraffic).
   5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
      a. Use O Joint Substrates: Aluminum coated with a high-performance coating.

G. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant:
   1. Available Products:
      a. Pecora Corporation; 898.
      b. Tremco; Tremsil 600 White.
   2. Type and Grade: S (single component) and NS (nonsag).
   3. Class: 25.
   4. Use Related to Exposure: NT (nontraffic).
   5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
      a. Use O Joint Substrates: Ceramic tile.

H. Multicomponent Nonsag Urethane Sealant:
   1. Available Products:
      a. Pecora Corporation; Dynatrol II.
      b. Tremco; Dymeric 511.
   2. Type and Grade: M (multicomponent) and NS (nonsag).

3. Class: 50.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.
    a. Use O Joint Substrates: Aluminum coated with a high-performance coating.

I. Multicomponent Pourable Urethane Sealant:
1. Available Products:
    a. Pecora Corporation; Dynatrol II-SG.
    b. Sika Corporation, Inc.; Sikaflex - 2c SL.
    c. Sonneborn, Division of ChemRex Inc.; SL 2.
2. Type and Grade: M (multicomponent) and P (pourable).
3. Class: 25.
4. Uses Related to Exposure: T (traffic) and NT (nontraffic).
5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

J. Single-Component Nonsag Urethane Sealant:
1. Available Products:
    a. Pecora Corporation; Dynatrol I-XL.
    b. Sika Corporation, Inc.; Sikaflex - 15LM.
    c. Tremco; DyMonic.
2. Type and Grade: S (single component) and NS (nonsag).
3. Class: 25.
4. Use Related to Exposure: NT (nontraffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

2.4 SOLVENT-RELEASE JOINT SEALANTS

A. Acrylic-Based Solvent-Release Joint Sealant: Comply with ASTM C 1311 or FS TT-S-00230.
1. Available Products:
    a. Tremco; Mono 555.

B. Butyl-Rubber-Based Solvent-Release Joint Sealant: Comply with ASTM C 1085.
1. Available Products:
    a. Sonneborn, Division of ChemRex Inc.; Sonneborn Multi-Purpose Sealant.
    b. Tremco; Tremco Butyl Sealant.

2.5 LATEX JOINT SEALANTS

A. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.

B. Available Products:
1. Pecora Corporation; AC-20+.
2. Sonneborn, Division of ChemRex Inc.; Sonolac.
3. Tremco; Tremflex 834.

2.6 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following:
   1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   2. Available Products:
      a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
      b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.

2.7 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F (minus 32 deg C). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
    a. Metal.
    b. Glass.
    c. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated

joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior vertical construction joints in cast-in-place concrete.
   1. Joint Sealant: Multicomponent nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

B. Joint-Sealant Application: Exterior horizontal nontraffic and traffic isolation and contraction joints in cast-in-place concrete slabs.
   1. Joint Sealant: Multicomponent pourable urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

C. Joint-Sealant Application: Exterior vertical control and expansion joints in unit masonry.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

D. Joint-Sealant Application: Exterior butt joints between metal panels.
   1. Joint Sealant: Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

E. Joint-Sealant Application: Exterior vertical joints between different materials listed above.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

F. Joint-Sealant Application: Exterior perimeter joints between unit masonry and frames of doors and windows.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

G. Joint-Sealant Application: Exterior control and expansion joints in ceilings and other overhead surfaces.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

H. Joint-Sealant Application: Vertical control and expansion joints on exposed interior surfaces of exterior walls.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.

2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

I. Joint-Sealant Application: Interior perimeter joints of exterior openings.
   1. Joint Sealant: Multicomponent nonsag urethane sealant or Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

J. Joint-Sealant Application: Interior ceramic tile expansion, control, contraction, and isolation joints in horizontal traffic surfaces.
   1. Joint Sealant: Multicomponent nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

K. Joint-Sealant Application: Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
   1. Joint Sealant: Single-component mildew-resistant neutral-curing silicone sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

L. Joint-Sealant Application: Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
   1. Joint Sealant: Single-component nonsag urethane sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

M. Joint-Sealant Application: Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
   1. Joint Sealant: Latex sealant.
   2. Joint-Sealant Color: As selected by Architect/Engineer from manufacturer's full range.

END OF SECTION 079200

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SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes hollow-metal work.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required.

E. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Ceco Door Products; an Assa Abloy Group company.
   2. Republic Doors and Frames.
   3. Steelcraft; an Ingersoll-Rand company.
   4. Fenestra Corporation.
   5. Trussbuilt, Inc.
   6. Or Equal.

2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed Lite Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.3 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

A. Heavy-Duty Doors and Frames: SDI A250.8, Level 2. At locations indicated in the Door and Frame Schedule.

1. Physical Performance: Level B according to SDI A250.4.
2. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches.
c. Face: Metallic-coated steel sheet, minimum thickness of 0.048 inch (18-gauge), with minimum A40 coating.
d. Edge Construction: Model 1, Full Flush.
e. Core: Polyurethane.

3. Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 11 when tested according to ASTM C 1363.

a. Materials: Metallic-coated steel sheet, minimum thickness of 0.06 inch (16-gauge), with minimum A40 coating.
b. Construction: Full profile welded.

4. Exposed Finish: Prime.

2.4 BORROWED LITES

A. Hollow-metal frames of metallic-coated steel sheet, minimum thickness of 0.053 inch.

B. Construction: Knocked down.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.075 inch (14-gauge) thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.06 inch (16-gauge) thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.06 inch (16-gauge), and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.6 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

C. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

D. Power-Actuated Fasteners in Concrete: From corrosion-resistant materials.

E. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing).

G. Glazing: Section 088000 "Glazing."

H. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat.

2.7 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
2. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
4. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
        1) Three anchors per jamb from 60 to 90 inches high.

    b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

        1) Three anchors per jamb up to 60 inches high.

    c. Compression Type: Not less than two anchors in each frame.
    d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

5. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

E. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow-metal work.
5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.8 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: SDI A250.10.

B. Factory Finish: SDI A250.3.

1. Color and Gloss: As selected by Owner from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hollow-Metal Frames: Install hollow-metal frames and borrow lites of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. At fire-rated openings, install frames according to NFPA 80.
b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
c. Install frames with removable stops located on secure side of opening.
d. Install door silencers in frames before grouting.
e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
5. Concrete Walls: Solidly fill space between frames and concrete with grout insulation.

6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.
8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

B. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
c. At Bottom of Door: 3/4 inch plus or minus 1/32 inch.
d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.2 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

SECTION 082210 - FIBERGLASS REINFORCED DOOR AND FRAME SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fiberglass Reinforced Plastic (FRP) Doors.

B. Fiberglass Door Frames.

C. Fiberglass Louvers.

D. Fiberglass Reinforced Plastic (FRP) Transoms.

1.02 RELATED SECTIONS

A. Section 087100 - Door Hardware.

B. Section 088000 - Glazing.

1.03 REFERENCES

A. ASTM D 523 - Standard Test Method for Specular Gloss.

B. ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

C. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. ASTM E 152 - Standard Methods of Fire Tests of Door Assemblies.

E. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

F. SDI 100 - Recommended Specifications for Steel Doors and Frames.

G. UL 10B - Standard for Fire Tests of Door Assemblies.

H. UL 305 - Standard for Panic Hardware.

1.04 PERFORMANCE REQUIREMENTS

A. Door opening assemblies:
   1. Maximum flame spread 25 in accordance with ASTM E 84, self-extinguishing in accordance with ASTM D 635.
   2. USDA accepted.

B. Fire rated assemblies: Comply with requirements of UL10B, NFPA 252, and ASTM E 152; UL rating, with doors and frames bearing rating labels for appropriate fire code of

the installation location/application.

C. Fire rated assemblies: Comply with requirements of UL10B, NFPA 252, and ASTM E 152; UL ratings indicated on drawings, with doors and frames bearing rating labels.

1.05 SUBMITTALS

A. Submit under provisions of Section 013300.

B. Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Shop Drawings:
1. Plans: Indicate location of each door opening assembly in project.
2. Elevations: Dimensioned elevation of each type door opening assembly in project; indicate sizes and locations of door hardware, and lites and louvers, if specified.
3. Details: Installation details of each type installation condition in project; indicate installation details of glazing, if specified.
4. Schedule: Indicate each door opening assembly in project; cross-reference to plans, elevations, and details.

D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

F. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.

G. Closeout: Submit warranty documents specified herein.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing fiberglass doors and frames with a minimum documented experience of ten years.

B. Installer Qualifications: Company specializing in installation of fiberglass doors and frames with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's unopened, undamaged packaging, with manufacturer's labels intact.

B. Inspect and report damage to doors at time of delivery.

C. Store products in manufacturer's unopened packaging until ready for installation.

D. Store door assemblies in on end, to prevent damage to face corners and edges.

1.08 WARRANTY

A. Manufacturer's Warranty: Manufacturer's 15-year warranty against failure due to corrosion from specified environment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer: Fib-R-Dor, Div. of Advance Fiberglass, Inc., which is located at: 7516 Counts Massie Rd.; N. Little Rock, AR 72113;

B. Substitutions: Or Equal

C. Provide all fiberglass doors and frames from a single manufacturer.

2.02 MATERIALS

A. Fiberglass Mat: Glass fiber chopped strand, minimum 1.5 ounces per square foot.

B. Resins: Manufacturer's formulation for fabricating units to meet specified requirements.

C. Anchors: Manufacturer's standard stainless steel expansion anchors for existing openings, and stainless steel masonry tee anchors for new construction.

D. Fasteners: Stainless steel.

E. Glazing: Type specified in Section 088000; factory installed.

F. Frames: 316 stainless steel unless noted otherwise in the Drawings.

2.03 COMPONENTS

A. Non-rated Fiberglass Reinforced Plastic (FRP) Doors:
   1. Thickness: 1-3/4 inches (45 mm).
   2. Thermal Insulating Value: 'R' factor 11.
   3. Construction:
      a. Core: End-grain balsa wood, resin-impregnated.
      b. Door Plates: Molded in one continuous piece, resin reinforced with hand-laid glass fiber mat, nominal 1/8 inch (3 mm) thick, minimum 15 mil gel-coated surface.
      c. Door Edges: Minimum 3 layers resin-reinforced glass fiber mat, nominal 3/8 inch (9.5 mm) thick, machine tooled.
   4. Sizes: Indicated on drawings.
   5. Finish: Smooth gloss surface, minimum value of 88 in accordance with ASTM D 523.

a. Color: By Owner

B. Fire-rated Fiberglass Reinforced Plastic (FRP) Doors:
1. Thickness: 1-3/4 inches (45 mm).
2. Thermal Insulating Value: 'R' factor 11.
3. Construction:
   a. Core: Fire-resistant mineral core.
   b. Door Plates: Molded in one continuous piece, resin reinforced with hand-laid glass fiber mat, nominal 1/8 inch (3 mm) thick, minimum 25 mil gel-coated surface.
   c. Door Edges: Minimum two layers resin-reinforced glass fiber mat, nominal 1/4 inch (6 mm) thick, machine tooled.
4. Sizes: Indicated on drawings.
5. Finish: Smooth gloss surface, minimum value 88 in accordance with ASTM D 523.
   a. Color: By Owner.

C. Non-rated Fiberglass Frames:
1. Construction: One-piece pultruded fiberglass reinforced plastic, minimum 1/4 inch wall thickness, jamb-to-head joints mitered and reinforced with FRP clips and stainless steel fasteners; conforming to SDI requirements for performance equivalent to 16 gage steel frames.
2. Frame profile: 5-3/4 inches (146 mm) deep, 2 inches (51 mm) wide face; double rabbeted with 5/8 inch (16 mm) high stop.
3. Sizes: Indicated on drawings.
4. Finish: Satin Co-Extruded finish, with true and consistent color throughout frame thickness.
   a. Color: By Owner

D. Fire-rated Frames: UL approved, and as follows:
1. Construction: Type 316 stainless steel.
2. Sizes: For door sizes and frame profiles indicated on drawings.

E. Frame Anchors: Stainless Steel.

F. Louvers in Non-rated Doors:
1. Construction: Molded solid vanes; pultruded fiberglass reinforced plastic construction.
2. Sizes: Indicated on drawings.
3. Finish: Satin pigmented finish, with true and consistent color throughout frame thickness.
   a. Color: By Owner

G. Lites in Non-rated Doors:
1. Stops: Pultruded fiberglass reinforced plastic construction.
2. Glazing: Specified in Section 088000.
3. Sizes: Indicated on drawings.
4. Fasteners: Stainless steel screws.

H. Lites in Fire-rated Doors: UL approved, and as follows:
1. Frames: Type 316 stainless steel.

2. Glazing: Specified in Section 088000.
3. Sizes: Indicated on drawings.
4. Fasteners: Stainless steel screws.

I. Fiberglass Reinforced Plastic (FRP) Transoms: Match adjacent door construction and color.

J. Door Hardware: Specified Section 087100.

2.04 FABRICATION

A. Fiberglass Reinforced Plastic (FRP) Doors:
1. Minimum glass fiber to resin ratio: 30 percent.
2. Mortise for lockset, and recess for strike plate in lock stile.
3. Embed steel reinforcement for hinges in fiberglass matrix; provide for hinge leaf recesses in hinge stile.

B. Fiberglass Frames:
1. Mortise for lock strike, and recess for strike plate in lock jamb.
2. Reinforce for hinges and other indicated hardware.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive work and opening dimensions and clearances are as indicated on approved shop drawings. Do not begin installation until openings have been properly prepared.

B. If opening preparation is the responsibility of another installer, notify Architect or Design Engineer of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Acclimate doors and frames to site conditions for a minimum of 24 hours before installation.

B. Do not remove labels from fire-rated doors and frames.

3.03 INSTALLATION

A. Install door opening assemblies in accordance with approved shop drawings, SDI 100, and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.

B. Use anchorage devices to securely fasten sliding door assembly to wall construction without distortion or imposed stresses.

C. Coordinate installation of thermal insulation at shim spaces at frame perimeter.

D. Installation of door hardware is specified in Section 087100.

E. Install door hardware in accordance with manufacturer's printed instructions, using through-bolts to secure surface applied hardware.

F. Site Tolerances: Maintain plumb and level tolerances specified in manufacturer's printed installation instructions.

3.04 ADJUSTING

A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding, and to remain in place at any angle without being moved by gravitational influence.

B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

3.05 CLEANING

A. Clean surfaces of door opening assemblies and sight-exposed door hardware in accordance with manufacturer's maintenance instructions.

B. Remove labels and visible markings.

3.06 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.07 SCHEDULE

A. Schedules: Refer to Door Schedule indicated on drawings.

END OF SECTION

SECTION 083200 –ACCESS HATCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor access hatches

1.2 RELATED SECTION

A. Section 055000 – Metal Fabrications

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop drawings: Show the following:
1. Access hatch installation recommendations
2. Locations of access hatches
3. Hatch size and configuration
4. Liveload capacity
5. Materials of construction and finishes provided

1.4 DELIVERY, STORAGE AND HANDLING

A. Identify type and size of each floor hatch in way not to damage finish prior to delivery

B. Deliver products only after proper facilities are available

C. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of use.

D. Handle carefully to prevent damage and store on clean concrete surface or raised platform in safe, dry area.

1. Do not dump onto ground.

E. Protect floor access hatches during shipment and storage to prevent warping, bending, and corrosion.

1.5 WARRANTY

A. Provide manufacturer's warranty against defects in material and workmanship for the life of the unit.

1.6 MAINTENANCE

A. Deliver 2 keys for each cylinder lock to the Owner.

PART 2 - PRODUCTS

A. ACCEPTABLE MANUFACTURERS

1. Halliday Products, Inc.
2. Bilco Co.
3. Or equal.

B. MATERIALS

1. The access hatch and cover shall have a ¼" thick one-piece, mill finish, extruded aluminum frame, incorporating a continuous concrete anchor. A bituminous coating shall be applied to the frame exterior where it will come in contact with concrete. Door panel(s) shall be ¼" aluminum diamond plate, reinforced to withstand a live load of 300 psf. Door(s) shall open to 90 degrees and automatically lock with T-3126 stainless steel hold-open arm(s) with aluminum release handle(s). For ease of operation the hold-open arm shall incorporate enclosed stainless steel compression spring assist. Door(s) shall close flush with the frame and rest on a built-in neoprene cushion/gasket. Hinges and all fastening hardware shall be T-316 stainless steel. Unit shall lock with a stainless steel slam lock and removable key. Unit shall carry a lifetime guarantee against defects in material and/or workmanship.
2. Where unit is specified to protect against water intrusion, a 1 ½" drainage coupling shall be located in the front left corner of the channel frame.
3. Where specified, unit shall be designed for H-20 load rating.

C. FINISHES

1. Floor access door finishes:
    a. Aluminum: Manufacturer's standard mill finish
    b. Aluminum in contact with dissimilar metals and concrete: Manufacturer's standard bituminous coating.
    c. Steel: Manufacturer's standard red oxide primer
2. Hardware finishes:
    a. Provide Type 316 stainless steel hardware throughout, including parts of the latch and lifting mechanism assemblies, hold open arms and all brackets, hinges, pins and fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine construction to receive floor access hatch and verify correctness of dimensions and

other supporting or adjoining conditions.

3.2 PREPARATION

A. Coordinate details with other work supporting, adjoining, or requiring access hatches.

B. Verify dimensions and profiles for each opening.

C. Verify that location will serve portion of work to which access is required.
   1. Where proposed functional location conflicts with other work, notify the Engineer before installation.

D. Apply coating to aluminum surfaces that will be in contact with dissimilar metals or concrete when there is none.

3.3 INSTALLATION

A. Install access hatches in accordance with manufacturer's instructions.

B. Ensure correct types and adequate sizes at proper locations.

C. Securely attach frames to supporting work and ensure hatches, frames and hardware operate smoothly and are free from warp, twist, and distortion.

3.4 ADJUSTING

A. Adjust hatches, frames and hardware to operate smoothly, freely, and properly without binding.

3.5 CLEANING

A. Thoroughly clean surfaces of grease, oil or other impurities; touch up abraded prime coat where applicable.

END OF SECTION

SECTION 083323 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Overhead coiling insulated doors.

1.2 RELATED SECTIONS

A. Section 055000 - Metal Fabrications: Support framing and framed opening.

B. Section 061000 - Finish Carpentry: Wood jamb and head trim.

C. Section 260533 - Raceway and Boxes: Conduit from electric circuit to door operator and from door operator to control station.

D. Section 262726 - Wiring Devices: Power to disconnect.

1.3 REFERENCES

A. NFRC 102 - Test Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems.

B. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Element.

C. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

D. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

E. ASTM A 666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

F. ASTM A 924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

G. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

I. NEMA MG 1 - Motors and Generators.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. Overhead coiling insulated doors:
   1. Wind Loads: Design door assembly to withstand wind/suction load as indicated on drawings without damage to door or assembly components in conformance with ASTM E 330.
   2. Operation: Design door assembly, including operator, to operate for not less than 20,000 cycles.

B. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

1.5 SUBMITTALS

A. Submit under provisions of Section 013300.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Details of construction and fabrication.
   4. Installation instructions.

C. Shop Drawings: Include detailed plans, elevations, details of framing members, anchoring methods, required clearances, hardware, and accessories. Include relationship with adjacent construction.

D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

E. Operation and Maintenance Data: Submit lubrication requirements and frequency, and periodic adjustments required.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years experience in the fabrication and installation of security

closures.

B. Installer Qualifications: Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.

C. Store materials in a dry, warm, ventilated weathertight location.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 COORDINATION

A. Coordinate Work with other operations and installation of adjacent materials to avoid damage to installed materials.

1.10 WARRANTY

A. Warranty: Manufacturer’s limited door and operator system, except the counterbalance spring and finish, to be free from defects in materials and workmanship for 3 years or 20,000 cycles, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Overhead Door Corp.
   2. Kinnear Corp.
   3. Pacific Rolling Door Co.
   4. Or equal.

2.2 INSULATED OVERHEAD COILING SERVICE DOORS

A. Overhead:
1. Curtain: Interlocking roll-formed slats as specified following. Endlocks shall be attached to each end of alternate slats to prevent lateral movement.
    a. Front slat fabricated of:
        1) 24 gauge galvanized steel.
    b. Back slat fabricated of:
        1) 24 gauge galvanized steel.
    c. Slat cavity filled with CFC-free foamed-in-place, polyurethane insulation.
        1) R-Value: 7.7, U-Value: 0.13.
        2) Sound Rating: STC-21.
2. Performance:
    a. Through Curtain Sound Rating: Sound Rating: STC-28 (STC-30+ with HZ noise generator) as per ASTM E 90.
    b. Installed System Sound Rating: STC-21 as per ASTM E 90.
    c. U-factor: 0.91 NFRC test report, maximum U-factor of no higher than 1.00.
    d. Air Infiltration: Meets ASHRAE 90.1 & IECC 2012/2015 C402.4.3 Air leakage <1.00 cfm/ft2.
3. Finish:
    a. Galvanized Steel: Slats and hood galvanized in accordance with ASTM A 653 and receive rust-inhibitive, roll coating process, including 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on polyester top coat.
        1) Polyester Top Coat.
            (a) Gray polyester.
        2) Non-galvanized exposed ferrous surfaces shall receive one coat of rust-inhibitive primer.
4. Weatherseals:
    a. Vinyl bottom seal, exterior guide and internal hood seals.
    b. Interior guide weatherseal.
5. Bottom Bar:
    a. Two galvanized steel angles minimum thickness 1/8 inch (3 mm) bolted back to back to reinforce curtain in the guides.
6. Guides: Three Structural steel angles
    a. Finish: PowderGuard Weathered finish with iron/black powder.
7. Brackets:
    a. Galvanized steel to support counterbalance, curtain and hood.
8. Counterbalance: Helical torsion spring type housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03 inch per foot of span. Counterbalance is adjustable by means of an adjusting tension wheel.
9. Hood: Provide with internal hood baffle weatherseal.
    a. 24 gauge galvanized steel with intermediate supports as required.
10. Manual Operation:
    a. Chain hoist.
11. Windload Design:
    a. Standard windload shall be as indicated on the drawings.

12. Locking:
    a. Chain keeper locks for chain hoist operation.
13. Wall Mounting Condition:
    a. Face-of-wall mounting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify opening sizes, tolerances and conditions are acceptable.

B. Examine conditions of substrates, supports, and other conditions under which this work is to be performed.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with Division 26. Complete wiring from disconnect to unit components.

F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 079200.

G. Install perimeter trim and closures.

H. Instruct Owner’s personnel in proper operating procedures and maintenance schedule.

3.4 ADJUSTING

A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.

B. Adjust hardware and operating assemblies for smooth and noiseless operation.

3.5 CLEANING

A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.

B. Remove labels and visible markings.

C. Touch-up, repair or replace damaged products before Substantial Completion.

3.6 PROTECTION

A. Protect installed products until completion of project.

END OF SECTION 083323

SECTION 086200 – UNIT SKYLIGHTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Tubular daylighting devices (TDD) and accessories

1.2 RELATED SECTIONS

A. 075423 – Thermoplatic Polyolefin (TPO) Roofing

B. 076200 – Sheet Metal Flashing

1.3 REFERENCES

A. American Architectural Manufacturers Association (AAMA):
   1. AAMA/WDMA/CSA 101/I.S.2/A440 - Standard/Specification for Windows, Doors, and Unit Skylights; 2011.

B. American National Standards Institute (ANSI):
   1. ANSI C63.4-2014 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

C. ASTM International (ASTM):
   1. ASTM A463/A463M - Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process.
   2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process.
   3. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
   4. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   5. ASTM D635 - Test Method for Rate of Burning and/or Extent of Time of Burning of Self-Supporting Plastics in a Horizontal Position.
   6. ASTM D1929 - Test Method for Ignition Properties of Plastics.
   7. ASTM D2843 - Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.
   8. ASTM F1642 - Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loading.
   9. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   10. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings.

11. ASTM E283 - Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
12. ASTM E308 - Standard Practice for Computing the Colors of Objects by Using the CIE System.
13. ASTM E330 - Structural Performance of Exterior Windows, Curtain Walls, and Doors.
14. ASTM E547 - Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain walls by Cyclic Air Pressure Difference.
15. ASTM E1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missiles and Exposed to Cyclic Pressure Differentials.
16. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricane.
17. ASTM F2912 - Standard Specification for Glazing and Glazing Systems Subject to Airblast Loading.

D. International Building Code (IBC):
1. IBC Section 1710 - Load Test Procedure for Wind Load Testing on Rooftop Daylight Collecting System - Structural Performance Testing - Devised by ATI PE); 2012.
2. IBC Section 2606.7.2 - Installation - Diffuser Fall Out Test (Devised by PE); 2012.

1.4 PERFORMANCE REQUIREMENTS

A. Daylight Reflective Tubes: Spectralight Infinity with INFRAREDuction Technology combines ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance. Patented spectrally-selective optical surface yields an average total- and specular-reflectance for the Visible Light spectrum (400 nm to 700 nm) providing maximized visible light transmission and less than 25 percent reflectance for Infrared (IR) heat wavelengths (750 nm to 2500 nm) for minimized heat transmission, resulting in a spectrally-selective Total Solar Spectrum (250 nm to 2500 nm) reflectance less than 37 percent, as measured using a Perkin Elmer Lambda 1050 spectrophotometer with a Universal Reflectance Accessory. Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance with ASTM E308.

1.5 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Data sheets showing roof dome assembly, flashing base, reflective tubes, diffuser assembly, and accessories.
4. Installation requirements.

C. Shop Drawings. Submit shop drawings showing layout, profiles, and product components, including rough opening and framing dimensions, anchorage, roof flashings and accessories.

D. Test Reports: Independent testing agency or evaluation service reports verifying compliance with specified performance requirements.

E. Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features:
   1. LED Luminaires: Include estimated useful life, calculated based on IES LM-80 test data.
   2. To meet LM-80 lifetime projections, LM-80 Max Drive Current must not be exceeded. Lumen maintenance and lifetime predictions are valid for drive current and case temperature conditions used for LM-80 testing as included in the applicable LM-80 test report for these products.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of twenty years experience in the top lighting industry. Secondary products shall be acceptable to the primary manufacturer.

B. Installer Qualifications: All products shall be installed by a single installer with a minimum of five years demonstrated experience, with adequate equipment, skilled workers, and practical experience to meet the project schedule.

C. Skylights shall conform with authorities having jurisdiction and be designed to meet design criteria of the project location and the following:
   1. Skylights must be certified by NFRC.
   2. Skylights must be Tested and labeled in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
   3. Skylights must have Factory Mutual (FM) Approval Class Number 4431.
   4. Meet or exceed OSHA 200 pound (90 kg) Drop Tests expressed in 29 CFR 1910.23(e)(8)
   5. Skylights shall provide minimum 69 psf (3.30 kPa) design load.

D. Pre-Installation Meeting: Contractor shall convene a pre-installation meeting with Engineer on the project site minimum one week before beginning work of this Section.
   1. Coordinate between at least the following trades.
      a. Roofing to install the flashing and skylight. Cut holes in roof deck, and flash curb to deck.
      b. Ensure clear paths for TDD units and coordinate with mechanical so not to interfere with pathways.
   2. Verify project requirements and site logistics.
   3. Assess integrity of the roofing system and building structure.
   4. Review manufacturer's installation instructions and warranty requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in a cool dry location protected from the weather and in the manufacturer's original unopened containers until ready for installation.

B. Store products in manufacturer's unopened packaging until ready for installation.

1.8 PROJECT CONDITIONS

A. Coordinate delivery schedule with the Contractor and project schedule to minimize on site storage.

B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

C. Store materials in a dry area, protected from freezing, staining, contamination or damage.

1.9 WARRANTY

A. Daylighting Device: Manufacturer's standard warranty for 10 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ACCEPTABLE MANUFACTURERS
1. SOLATUBE
2. Or Approved Equal

B. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 TUBULAR DAYLIGHTING DEVICES

A. Tubular Daylighting Devices General: Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16.

B. SolaMaster Series: Solatube Model 750 DS, Daylighting System:
1. Model:
a. Solatube Model S750DS-C-DAI-CXX-CI-AK-EXX-TM-L2-I Closed (Penetrating) Ceiling. AAMA Type TDDCC.
2. Capture Zone:
a. Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
1) Outer Dome Glazing: Type DA, 0.125 inch (3.2 mm) minimum thickness injection molded acrylic classified as CC2 material; UV inhibiting (100 percent UV C, 100 percent UV B and 98.5 percent UV A), impact modified acrylic blend.

a) Raybender 3000: Variable prism optic molded into outer dome to capture low angle sunlight and limit high angle sunlight.

2) Acrylic Dome plus Inner Dome Glazing: Type DAI, Inner Dome is 0.115 inch (3 mm) minimum thickness acrylic classified as CC2 material.

b. Tube Ring: 0.090 inch (2.3 mm) nominal thickness injection molded ASA. Prevents thermal bridging between base flashing and tubing and channel condensed moisture. Attached to base of dome ring with butyl glazing rope 0.24 inch (6 mm) diameter; to minimize air infiltration.

c. Dome Seal: Adhesive backed weatherstrip, 0.63 inch (16 mm) tall by 0.28 inch (7 mm) wide.

3. Dome Options:

a. Security Kit: Type SK Dome Security Kit, rivets with nylon spacers to replace dome screws.

4. Flashings:

a. Curbs: Metal Insulated Roof Curb: Corrosion resistant 18 Gauge hot-dipped galvanized steel conforming to ASTM A653 G90 with continuous welded seams, integrated base plate for water tightness and extra strength, lined with 1-1/2 inch fiberglass fireproof sound attenuating thermal insulation, factory installed 2 by 2 treated wood nailer secured to top ledge of curb. Curb designed for single-ply roofing, lightweight fill, or tapered insulation low slope roof types.

1) CXX Metal insulated curb with a custom curb height as determined by the CONTRACTOR.

5. Transfer Zone:

a. Extension Tubes: Aluminum sheet, thickness 0.018 inch (0.5 mm) conforming to ASTM B 209.

1) Reflective Tubes:

a) Reflective extension tube, Type EXX and Type EL with total length of run as indicated on the Drawings.

b) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.

2) Tube Options

a) Top Tube Angle Adapter and Bottom Tube Angle Adapter Kit: Type AK, Reflective 45 degree adjustable top and bottom angle adapters (one each), 16 inches (406 mm) long

b) Wire Suspension Kit: Type E, Use the wire suspension kit when additional bracing to the structure is required.

6. Delivery Zone:

a. Diffuser Assemblies for Tubes Penetrating Ceilings: Solatube Model 750 DS-C. Ceiling mounted box transitioning from round tube to square ceiling assembly, supporting light transmitting surface at bottom termination of tube; 23.8 inches by 23.8 inches (605 mm by 605 mm) square frame to fit standard suspended ceiling grids or hard ceilings.

1) Polymeric Transition Box: Type TP, round-to-square transition box made of opaque polymeric material, classified as CC2, Class C, 0.110 inch (2.8 mm) thick.

2) Lens: Type L5 (Wide), OptiView Micro-replicated lens design to maximize light output and diffusion. Visible Light Transmission shall be greater than 90 percent at 0.022 inch (0.6 mm) thick. Classified as CC2.

3) Round Metal Housing: Type TRH, Round metal housing for hard ceilings. Comprised of white powder coated 26 gauge galvanized sheet steel, a Spectralight Infinity sleeve and a white powder coated 24 gauge steel ceiling mounting plate.

C. SkyVault Series: Solatube Model SM74DS-O-DP-CXX-E1-A-L2-I.
1. Capture Zone:
a. Domes:
1) Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
a) Fasteners: Non-corrosive metal fasteners including non-magnetic stainless steel, zinc plated steel, aluminum, or injection molded nylon.
b) Dome Edge Protection Band: For Classified Roof Assemblies. For approved assemblies, curb height (by others or built on site) must be more than 8 inches (203 mm). Galvanized steel. Nominal thickness of 0.039 inch (1 mm).
2) Single Dome Glazing: Type DP.
a) Outer Dome Glazing: 0.125 inch (3.2 mm) minimum thickness, vacuum formed polycarbonate classified as CC1 material; UV inhibiting (100 percent UVC, 100 percent UVB and 98.8 percent of the range of UVA transmission).
b) Outer Dome Seals: Adhesive Back Closed Cell Foam Seal 0.25 inch (6.3 mm) tall by 0.75 inch (19 mm) wide.
b. Dome Options:
1) Security Guard: Type SG, welded powder coated steel or stainless steel rods 1/8 inch diameter mounted with an 8 inch maximum cross section. Assembly fastened with 1/8 inch diameter blind rivets in 6 locations to Curb-Cap assembly.
c. Flashings:
1) Curb Cap Flashing Base: Type FC one piece, seamless, leak-proof flashing, and base support for dome and top of tube and cap flashing. Fabricated of corrosion resistant sheet steel, conforming to ASTM A653/A653M or ASTM A463/A463M or ASTM A792/A792M, with a thickness of 0.0276 inch (0.7 mm) plus or minus .004 inch (.01 mm).
a) Base Style: Curb-cap, with inside dimensions of 35.5 inches by 35.5 inches (905 mm by 905 mm) to cover curb specified in Section 07600.
b) Insulation: Nominal 1 inch thick thermal isolation pad to reduce thermal conduction between curb-cap and tubing and thermal convection between room air and curb-cap. Rated R-6 (OFxft2xhr/Btu) Insulation is Polyisocyanurate foam utilizing CFC, HCFC, and HFC free blowing agent. Type-1 Class-1 per ASTM C 1289; Passes UL 1715 (15-minute thermal barrier per IBC 2603.4); Attic ventilation may be required per IBC 1203.2.
c) Curb Seal: Includes a double bead of adhesive backed closed cell foam seal 0.188 inch (4.8mm) tall by 0.375 inch (9.5mm) wide to reduce air infiltration.
d) Tube Collar: Attached to top of curb-cap section; 0.018 inch (0.45 mm) nominal thickness aluminum conforming to ASTM B 209.

e) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.

d. Curbs: Metal Insulated Roof Curb: Corrosion resistant 18 Gauge hot-dipped galvanized steel conforming to ASTM A653 G90 with continuous welded seams, integrated base plate for water tightness and extra strength, lined with 1-1/2 inch fiberglass fireproof sound attenuating thermal insulation, factory installed 2 by 2 treated wood nailer secured to top ledge of curb. Curb designed for single-ply roofing, lightweight fill, or tapered insulation low slope roof types.

1) CXX Metal insulated curb with a custom curb height as determined by the CONTRACTOR.

2. Transfer Zone:

a. Extension Tubes: Aluminum sheet, thickness 0.018 inch (0.5 mm) conforming to ASTM B 209 with Tab-Lock tube joint structural connection system.

1) Reflective Tubes:

a) Reflective 24 inch (610 mm) extension tube, Type EXX or Type EL with total length of run as indicated on the Drawings.

b) Belt Alignment Tab aligns Tube Belt on to tube in the correct location.

c) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.

2) Tab-Lock:

a) Tab-Lock captures adjoining tube or tube connector using periodic opposing hooks integrated in the tube perimeter with mating retention detents.

b) Hook system allows ease of tube engagement or disengagement for single operator from man-lift or rooftop.

c) System intertwines the ends of the adjoining tubes and tube connectors between each Tab-Lock station.

d) Intertwining function accepts tubes and connectors of common diameters that reduces light loss up to 2 percent per tube joint relative to tubes with 0.3 inch (7.6 mm) diameter difference.

3) Tube Belt:

a) Sheet-metal belt 2 inch (50.8 mm) wide by 28.5 inch (724 mm) nominal diameter by 0.022 inch (0.5 mm) thick CS-B AZ-50 ASTM A792 with 0.10 inch (2.5mm) diameter stainless steel type 302 ASTM A313 torsion spring actuated toggle clamp.

b) Retains Tab-Lock tube joint structural connection system; stiffens linear tube assembly; and prevents tube rotation or disengagement under normal use.

c) Includes locking tab to prevent unintentional Tube Belt Latch opening due to handling, service, vibration, or normal operation or use.

3. Delivery Zone:

a. Bottom Assembly:

1) Amplifier Assembly for Tubes Not Penetrating Ceilings (Open Ceiling): Type A, 36 inch (914 mm) diameter amplifier diffuser assembly attached directly to bottom of tube.

a) Amplifier: Conical shaped assembly 23.7 inches (602 mm) tall, 28.5 inches (724 mm) upper diameter, and 36 inches (914 mm) lower diameter.
b) Amplifier collimates incident light. Light reflects off 2 successively angled facets designed to mix the light to reduce glare and to correct the incident angle by 15 degrees and 25 degrees successively thereby improving the transmission efficiency through the diffuser lens by reducing retro-reflection due to first surface refraction and concentrating the distribution of light by reducing the cone of illumination relative to the incident angle correction.
c) Assembly comprised of 3 multifaceted segments to be joined together with 15 - 0.125 Inch (3 mm) rivets.
d) Tube Connect Slots at upper perimeter receive 6 Tab-Lock Hook features from adjoining tube for mechanical tube engagement.
e) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.
f) Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance with ASTM E308.
g) Amplifier Diffuser Belt:
h) Sheet-metal belt 2 inch (50.8 mm) wide by 36 inch (914mm) nominal diameter by 0.022 inch (0.5 mm) thick CS-B AZ-50 ASTM A792 with 0.10 inch (2.5 mm) diameter stainless steel Type 302 ASTM A313 torsion spring actuated toggle clamp.
i) Retains Tab-Lock tube joint structural connection system; stiffens linear tube assembly; and prevents tube rotation or disengagement under normal use.
j) Includes locking tab to prevent unintentional Latch opening due to handling, service, vibration, or normal operation or use.

2) Diffuser Lens:
a) Lens: Type L2, Prismatic lens designed to maximize light output and diffusion. Visible Light Transmission shall be greater than 90 percent at 0.100 inch (2.5 mm) thick. Classified as CC2.
b) Diffuser Collar: Attached to diffuser lens; 0.018 inch (0.45 mm) nominal thickness aluminum.
c) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.
d) Diffuser Seal: "L" shaped EPDM closed cell foam 0.86 inch (21.8 mm) wide by 1.37 inch (34.8mm) tall by 0.16 inch (4.1 mm) thick to minimize condensation and bug, dirt, and air infiltration per ASTM E283.
e) Diffuser Band: Stainless steel diffuser band, 0.25 inch (6.4 mm) wide by 0.020 inch (0.5 mm) thick stainless steel Type 201 ASTM A666, for enhanced seal performance and protection.

2.3 ACCESSORlES

A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.

B. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.

C. Sealant: Polyurethane or copolymer based elastomeric sealant as provided or recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Examine openings, substrates, structural support, anchorage, and conditions for compliance with requirements for installation tolerances and other conditions.

C. If substrate and rough opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Coordinate requirements for power supply, conduit, and wiring.

C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Coordinate installation with substrates, air and vapor retarders, roof insulation, roofing membrane, and flashing to ensure that each element of the Work performs properly, and that finished installation is weather tight.
   1. Install flashing to produce weatherproof seal with curb and overlap with roofing system termination at top of curb.
   2. Provide thermal isolation when components penetrate or disrupt building insulation. Pack fibrous insulation in rough opening to maintain continuity of thermal barriers.
   3. Coordinate attachment and seal of perimeter air and vapor barrier material.

C. Where metal surfaces of tubular unit skylights will contact incompatible metal or corrosive substrates, including preservative-treated wood, provide permanent separation as recommended by manufacturer

D. Align device free of warp or twist, maintain dimensional tolerances.

E. Inspect installation to verify secure and proper mounting. Test each fixture to verify operation, control functions, and performance. Correct deficiencies.

3.4 FIELD QUALITY CONTROL

A. Provide independent testing and inspection as specified in Section 01 45 23. Inspect installation to verify secure and proper mounting.
   1. Test for water leaks in accordance with AAMA 502 after installation and curing of sealants but prior to installation if interior finishes.
   2. Perform test for total area of each unit skylight.
   3. Notify the Architect and the Contractor of any failed tests.

3.5 CLEANING

A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 086200

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Mechanical door hardware for the following:
   a. Swinging doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

   a. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
   b. Content: Include the following information:

      1) Identification number, location, hand, fire rating, size, and material of each door and frame.
      2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
      3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
      4) Description of electrified door hardware sequences of operation and interfaces with other building control systems.

2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

B. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

C. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.

D. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
2. Comply with the following maximum opening-force requirements:

    a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
    b. Sliding or Folding Doors: 5 lbf applied parallel to door at latch.
    c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

F. Keying Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

B. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

a. Exit Devices: Two years from date of Substantial Completion.
b. Manual Closers: 10 years from date of Substantial Completion.
c. Concealed Floor Closers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled on Drawings or as described herein to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements.
2. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2.2 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

B. A minimum of three (3) hinges shall be provided for each door leaf up to and including 7-foot in height and an additional hinge shall be added for each 2-foot or fractions thereof of additional door height.

C. All hinges shall be full mortise, 4 inches high, heavy duty, 4-ball bearings, stainless steel, Hager Companies, BB1541 or equal, unless shown otherwise in the drawings.

2.3 SURFACE CLOSERS

A. BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's

written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force. All exposed materials of the closer shall be corrosion-resistant.

B. Closers shall be Dorma STA 8916 AF86P COV SNDPK or equal, unless shown otherwise in the drawings.

2.4 MECHANICAL LOCKS AND LATCHES

A. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

B. Bored Locks: BHMA A156.2; Grade 1; Series 4000.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Schlage Commercial Lock Division; an Ingersoll-Rand company.
   b. Yale Security Inc.; an ASSA ABLOY Group company.

C. Mortise Locks: BHMA A156.13; Operational Security Grade 1; stamped steel case with steel or brass parts; Series 1000.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Schlage Commercial Lock Division; an Ingersoll-Rand company.
   b. Yale Security Inc.; an ASSA ABLOY Group company.

2.5 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Yale Security Inc.
   b. Dorma-USA

2. All exit devices shall be Yale 2100 series, 630 finish, or equal, unless shown otherwise on the drawings. Trim shall be as indicated in the schedule.

2.6 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from stainless steel.

1. Manufacturer: Same manufacturer as for locking devices.
2. Cylinders must be compatible with existing cores.
3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Schlage Commercial Lock Division; an Ingersoll-Rand company.
   b. Yale Security Inc.; an ASSA ABLOY Group company.

B. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

C. Construction Cores: Determine at keying conference.

2.7 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

   a. Notation: "DO NOT DUPLICATE."

2. Quantity: Determine at a keying conference. Such conference shall include, at a minimum, the plant manager.

2.8 MECHANICAL STOPS AND HOLDERS

A. Wall-Mounted Stops: BHMA A156.16; aluminum base metal. Convex rubber stops. Hager 232W or equal.

B. Floor-Mounted Stops: BHMA A156.16; aluminum base metal. Low profile dome stop. Hager 241F or equal.

C. Wall-Mounted stops shall be used, where possible.

2.9 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer. All mounting hardware shall be stainless steel.

B. Gasketing shall be Pemko 303 AV or equal, unless shown otherwise in the drawings.

2.10 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated, extruded aluminum with a maximum ½ inch rise. Thresholds shall be installed with a sealer to prevent water from seeping underneath.

B. Thresholds shall be Pemko 171A or equal, unless shown otherwise in the drawings.

2.11 METAL KICKPLATES

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- thick stainless steel; with manufacturer's standard stainless steel machine or self-tapping screw fasteners. Width shall be door size less 2 inches. Kickplates shall be Trimco 10” x 2” Less Door Width (LDW) 630 or equal.

2.12 DOOR SWEEP

A. Door Sweeps: Stainless steel with black neoprene insert. Hardware shall be stainless steel. Sweep shall be Pemko 3151SSN or equal, unless shown otherwise in the drawings.

2.13 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated. All fasteners shall be stainless steel.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.14 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

B. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

C. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

D. All hardware shall be installed or reinstalled after the final paint coat has been applied and has dried.

E. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

F. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches of door height greater than 90 inches.

G. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as directed by Owner.

H. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

I. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.

1. Configuration: Provide one power supply for each door opening with electrified door hardware.

J. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

K. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

L. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

M. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

N. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

O. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

END OF SECTION

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Doors.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified professional engineer, using the following design criteria:

1. Design Wind Pressures: As indicated on Drawings.
2. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.

1.4 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Preconstruction adhesion and compatibility test report.

1.6 QUALITY ASSURANCE

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.

D. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

1.7 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge

separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: Five years from date of Substantial Completion.

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes basic-protection testing requirements in ASTM E 1996 for Wind Zone 1 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.

1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located more than 30 feet above grade.
3. Large-Missile Test: For all glazing, regardless of height above grade.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

A. Glass Specifications: Glass shall conform to Federal Specification DD-G-451D and Federal Specifications DD-G-1403B(1) (Tempered Glass). Insulating glass shall conform to SGMA 65-7-2.

B. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

C. Type A: Tinted, colored float glass shall be not less than 1/4-inch minimum thickness. The glass color shall be gray. Type A glass shall be PPG, "Solargray"; LOF, "Monolithic Gray"; or equal.

D. Type B: Tinted, colored, tempered float glass shall be heat-treated safety glass 1/4-inch minimum thickness, such as PPG, "Herculite - Solargray"; LOF, "Thermopane - Monolithic Gray"; or equal. The glass color shall be gray.

E. Type C: Clear float glass shall conform to Federal Specification DD-G-451D and shall be not less than 1/4-inch thick. Type C glass shall be PPG, "Pennvernon"; LOF, "Monolithic Annealed Glass"; or equal.

F. Type D: Clear, tempered float glass shall be heat-tempered safety glass conforming to Federal Specification DD-G-1403B(1) and shall be not less than 1/4-inch thick.

G. Type G: Tinted, colored, insulating glass shall be metal-edged units of 1-inch thickness, consisting of an outside lite of 1/4-inch thick, tinted, colored gray float glass; 1/2-inch air space; and 1/4-inch thick, clear float glass inside lite. Provide tempered glass as described above where required by code and where indicated in the drawings.

2.3 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.

1. Sealing System: Dual seal.
2. Spacer: Manufacturer's standard spacer material and construction.

2.4 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:

1. Neoprene complying with ASTM C 864.
2. EPDM complying with ASTM C 864.
3. Silicone complying with ASTM C 1115.
4. Thermoplastic polyolefin rubber complying with ASTM C 1115.

2.5 GLAZING SEALANTS

A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.6 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

B. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

C. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

E. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

F. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance or impair appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.2 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Apply heel bead of elastomeric sealant.

F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.4 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION

SECTION 089119 - FIXED LOUVERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Extruded aluminum stationary louvers with drainable blades.

B. Adjustable wall louvers.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete.

B. Section 05 20 00 - Structural Steel Framing.

C. Section 06 10 00 - Rough Carpentry.

D. Section 07 42 00 - Metal Wall Panels.

E. Section 07 60 00 - Flashing and Sheet Metal.

F. Section 07 92 00 - Joint Sealants.

G. Section 13 40 00 – Pre-Engineered Metal Buildings

1.3 REFERENCES

A. AAMA 2604 – High Performance Organic Coatings on Architectural Extrusions and Panels.

B. AAMA 2605 - High Performance Organic Coatings on Architectural Extrusions and Panels

C. AAMA 611 – Voluntary Specification for Anodized Architectural Aluminum.

D. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

E. AMCA 511 - Certified Ratings Program for Air Control Devices.

F. ASCE 7 - Minimum Design Loads for Buildings and Other Structures

G. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

H. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

I. ASTM D822 - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings

J. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

K. ASTM D2244 - Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates.

1.4 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

D. Rain-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.5 ACTION SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. Product Data: For each product to be used, including:
   1. Manufacturer's product data including performance data.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods.

C. Shop Drawings:
   1. Submit shop drawings indicating materials, construction, dimensions, accessories, and installation details.

D. Product Schedule: For louvers. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.

B. Product Test Reports: For each type of louver, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For manufacturer's warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. The manufacturer shall have implemented the management of quality objectives, continual improvement, and monitoring of customer satisfaction to assure that customer needs and expectations are met.
   2. Manufacturer shall be International Organization for Standardization (ISO) 9001 accredited.

B. Product Qualifications:
   1. Louvers licensed to bear AMCA Certified Ratings Seal. Ratings based on tests and procedures performed in accordance with AMCA 511 and comply with AMCA Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance and water penetration ratings.
   2. Louvers shall be factory engineered to withstand the specified seismic loads.
      a. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction (AHJ).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions.

C. Handling: Protect materials and finishes during handling and installation to prevent damage.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.10 WARRANTY

A. Manufacturer shall provide standard limited warranty for louver systems for a period of five years (60 months) from date of installation, no more than 60 months after shipment from manufacturing plant. When notified in writing from the Owner of a manufacturing defect, manufacturer shall promptly correct deficiencies without cost to the Owner.

B. Manufacturer shall provide 20-year limited warranty for fluoropolymer-based finish on extruded aluminum substrates.
   1. Finish coating shall not peel, blister, chip, crack or check.
   2. Chalking, fading or erosion of finish when measured by the following tests:

a. Finish coating shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D4214.
b. Finish coating shall not change color or fade in excess of 5 NBS units as determined by ASTM D2244 and ASTM D822.
c. Finish coating shall not erode at a rate in excess of 10%/ 5 year as determined by Florida test sample.

C. Manufacturer shall provide 5 years limited warranty for Class I and a 3 year limited warranty for Class II anodized finish on extruded aluminum substrates.
1. Seller warrants the Finish under normal atmospheric conditions.
a. Will not crack, craze, flake or blister
b. Will not change or fade more than (5) Delta-E Hunter units as determined by ASTM method D-2244
c. Will not chalk in excess of ASTM D-4214-07 number (8) rating, determined by the procedure outlined in ASTMD-4214-07 specification test.
2. Any forming or welding must be done prior to finishing. Post forming or welding will void the warranty.
3. This Warranty applies only if the anodized aluminum product is installed in strict accordance with Seller's recommended practices and maintained in accordance with AAMA (American Architectural Manufacturers Association) publication number 609 and 610-09 ("Cleaning and Maintenance Guide for Architecturally Finished Aluminum").

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Ruskin Company

B. Substitutions: Or equal.

2.2 STATIONARY BLADE LOUVER

A. Fabrication:
1. Design: Stationary drainable louver type with drain gutters in each blade and head with downspouts in jambs and mullions with all welded construction. Hidden vertical supports to allow continuous line appearance up to 120 inches. Steeply angled integral sill.
2. Frame:
a. Frame Depth: 6 inches.
b. Wall Thickness: 0.081 inch, nominal.
c. Material: Extruded aluminum, Alloy 6063-T6.
3. Blades:
a. Style: Drainable. 37.5 degrees at 5-29/32 inches, nominal.
b. Wall Thickness: 0.081 inch, nominal.
c. Material: Extruded aluminum, Alloy 6063-T6.
4. Minimum Assembly Size: 12 inches wide by 12 inches high.

5. Maximum Factory Assembly Size: Single sections shall not exceed 120 inches wide by 90 inches high or 90 inches wide by 120 inches high. Louvers larger than the maximum single size shall be require field assembly of smaller sections.

B. Performance Data:
1. Based on testing 48 inch x 48 inch size unit in accordance with AMCA 500.
2. Free Area: 57 percent, nominal.
3. Free Area Size: 9.08 square feet.
4. Maximum Recommended Air Flow through Free Area: 1023 feet per minute.
5. Air Flow: 9289 cubic feet per minute.
6. Maximum Pressure Drop (Intake): 0.15 inches w.g.
7. Water Penetration: Maximum of 0.01 ounces per square foot of free area at an air flow of 1,023 feet per minute free area velocity when tested for 15 minutes.

C. Design Windload: Incorporate structural supports required to withstand wind load as indicated in drawings.

D. Louvers shall be factory engineered to withstand the specified seismic loads.
1. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction (AHJ).

2.3 ADJUSTABLE LOUVER

A. Fabrication:
1. Design: Louver shall include a low leak adjustable blade within a 6 inch frame. Design incorporates visible mullions or frames at the perimeter of the louver and also at certain intervals within the louver perimeter to support the louver blades. Louver blade sightlines are interrupted at the mullion locations. No rear-mounted blade supports are visible from front. Steeply angled integral sill eliminating areas of standing or trapped moisture where mold or mildew may thrive and effect indoor air quality.
2. Frame:
   a. Material: Extruded aluminum, Alloy 6063-T5.
   b. Wall Thickness: 0.081 inch, nominal.
   c. Depth: 6 inches.
   d. Construction: Standard.
   e. Downspouts and caulking surfaces.
3. Blades:
   a. Style: Drainable.
   b. Material: Extruded aluminum, Alloy 6063-T5.
   c. Wall Thickness: 0.081 inch nominal.
   d. Angle: 37.5 degrees.
   e. Centers: 6 inches, nominal.

B. Performance Data:
1. Based on testing 48 inch x 48 inch size unit in accordance with AMCA 500.
2. Free Area: 54 percent, nominal.
3. Free Area Size: 8.71 square feet.
4. Maximum Recommended Air Flow Thru Free Area: 846 feet per minute.
5. Air Flow: 7,369 cubic feet per minute.

6. Maximum Pressure Drop: 0.12 inches w.g.
7. Water Penetration: Maximum of 0.01 ounces per square foot of free area at an air flow of 846 feet per minute free area velocity when tested for 15 minutes.

C. Design Windload: Incorporate structural supports required to withstand wind load as indicated in drawings.

D. Louvers shall be factory engineered to withstand the specified seismic loads.
1. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction (AHJ).

2.4 FIBERGLASS STATIONARY LOUVER

A. Furnish and install, at locations shown in plans, or in accordance with schedules, fiberglass stationary bladed louvers. Louvers shall be of pultruded construction and comply with ASTM D 4385-8A and be tested and show record for ASTM D 2584-68.

B. Material used in construction shall be a flame retardant vinyl ester based substance. All material in airstream must meet or exceed required contamination concentration. All exposed glass shall be coated with resin compatible with that used in the pultrusion process.

C. Stationary fiberglass louvers shall be Ruskin Swartwout Series Model SFG40 construction as follows:
1. Frame: 4" x 1.06" fiberglass channel, .125" (3.2) thick.
2. Blades: .125" thick fiberglass on 45° angle approximately 5" center to center.
3. Screen: .50" mesh x 19 gauge PVC coated birdscreen.

D. Published louver performance data must be submitted for approval prior to fabrication and must demonstrate pressure drop and water penetration equal to or less than the specified model. Louver must carry the AMCA Certified Ratings Seal for Air Performance and Water Penetration.

2.5 ACCESSORIES

A. Bird Screen:
1. Aluminum: Aluminum, 5/8 inch by 0.040 inch, expanded and flattened. Frame: Removable.

2.6 FINISHES

A. Finish for steel louvers: 70 percent PVDF: Finish shall be applied at 1.2 mil total dry film thickness.
1. Coating shall conform to AAMA 2605. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
2. 20-year finish warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect areas to receive louvers. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.

B. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean opening thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install louvers at locations indicated on the drawings and in accordance with manufacturer's instructions.

B. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.

C. The supporting structure shall be designed to accommodate the point loads transferred by the louvers when subject to the design wind loads.

D. Install joint sealants as specified in Section 07 92 00.

3.4 CLEANING

A. Clean louver surfaces in accordance with manufacturer's instructions.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.
3. Joint Treatment Materials
4. Accessories and Trim

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples:
1. Board: Submit a 6 inch square sample of each panel product.
2. Trim: Submit a 6 inch sample of each trim product.

1.3 QUALITY ASSURANCE

A. Qualifications: Installer shall have experience with installation of gypsum board under similar conditions.

B. Mock-ups:
1. Install mock-up using approved gypsum products, including fasteners and related accessories per manufacturer's current printed instructions and recommendations.
   a. Mock up size: 8' by 8'
   b. Provide mock-up for each type of gypsum board used
   c. Mock-up Substrate: Match wall assembly construction
   d. Mock up may remain as part of the work

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original packaging indicating manufacturer and product name.

B. Store products in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. CertainTeed Gypsum

B. National Gypsum Company

C. USG Corporation

D. Or Equal

2.2 INTERIOR GYPSUM BOARD

A. Moisture and Mold Resistant Gypsum Board: Gypsum core panel with enhanced core formulated for resistance to moisture and mold; for use in fire-resistant Type X designs. Surfaced with moisture/ mold resistant paper on front, back, and long edges. Complying with ASTM C1396.

1. ProRoc® Moisture and Mold Resistant With M2TECH™ Type X Gypsum Board by CertainTeed Gypsum, Inc., or Equal
2. Thickness: 5/8 inch
3. Width: 48 inches
4. Length: Use longest length to minimize joints
5. Edges: Tapered
6. Mold Resistance: Panel score of 10 (highest rating available) when tested in accordance with ASTM D3273

2.3 TILE BACKING PANELS

A. Fully embedded glass mat moisture resistant gypsum tile backer meeting the requirements of ASTM C 1178.
1. CertainTeed Gypsum, Inc. Diamondback™ GlasRoc® Tile Backer" with EGRG™ technology, or equal
2. Type and Thickness: Type X, 5/8 inch (15.9 mm) thick.
3. Standard Size: 4 feet by 8 feet
4. Mold Resistance: Panel score of 10 (highest rating available) when tested in accordance with ASTM D3273.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:
1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

E. Material shall be moisture-resistant and not affected by humidity after final hardening.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Screws shall be self-drilling, self-tapping, bugle head for use with power tools, length as recommended by Gypsum Association referenced standards and the Building Code.
a. Type "S" for wallboard to sheet metal application.
b. Type "W" for wallboard to wood application.
c. Type "G" for wallboard to wallboard application.
d. Type "S" or "S-12", 1-1/4 inch for tile backing board to metal studs application.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing).

D. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.

E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

F. Vapor Retarder: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

A. Comply with ASTM C 840.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

D. Install trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

1. Aluminum Trim: Install in locations indicated on Drawings.

E. Prefill open joints and damaged surface areas.

F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 3: Areas to receive heavy or medium textured coatings; heavy grade wall coverings.
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

    a. Primer and its application to surfaces are specified in Section 099000 "Architectural Paint Finishes"

5. Level 5: Areas to receive gloss, semi-gloss sheen paints

    a. Primer and its application to surfaces are specified in Sections 098000 “Protective Coatings” and 099000 "Architectural Paint Finishes"

H. Texture Finish Application: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.

I. Protect adjacent surfaces from drywall compound and texture finishes and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

J. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 098000 - PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes the surface preparation and application requirements of paint systems as specified herein.

B. The coating system schedule included in the drawings, and the specifications herein identify the surfaces to be coated with the designated coating system number including the required surface preparation, and the products to be applied. If used, coating notes on the Drawings are to show or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.

C. Scope of Work

1. The Contractor shall furnish all materials, labor, equipment, and incidentals required to provide a protective coating system for the surfaces listed herein and not otherwise excluded.
2. The work includes surface preparation and cleaning, painting and finishing of interior and exterior exposed items and surfaces such as ceilings, walls, floors, miscellaneous metal, doors, frames, construction signs, guardrails, posts, pipes, fittings, valves, equipment, and all other work obviously required to be painted unless otherwise specified herein or on the Drawings. The omission of minor items in the schedule of work shall not relieve the Contractor of his obligation to include such items where they come within the general intent of the Specifications as stated herein.

1.2 REFERENCES

A. American National Standards Institute:

1. ANSI/NSF Standard 61 Listing of Certified Drinking Water System Components - Health Effects.
2. ANSI Z53.1, Safety Color Code for Marking Physical Hazards.

B. ASTM International (ASTM):

1. ASTM D4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
2. ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages
3. ASTM D4417 – Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel.
4. ASTM D6386 – Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
5. ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

6. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

C. International Concrete Repair Institute (ICRI):

1. Guideline No. 310.1 – Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
2. Guideline No. 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealer, Linings, and Polymer Overlays

D. NACE International, (NACE)

1. NACE RP0287 – Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
2. NACE SP0188 – Standard Practice for Discontinuity (Holiday) Testing of Protective Linings
3. NACE No. 1/SSPC-SP 5 - White Metal Blast Cleaning.
4. NACE No. 2/SSPC-SP 10 - Near-White Metal Blast Cleaning.
5. NACE No. 3/SSPC-SP 6 Commercial Blast Cleaning
6. NACE No. 6/SSPC-SP13 – Surface Preparation of Concrete

E. National Association of Pipe Fabricators (NAPF)

1. NAPF 500-03 – Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

F. Occupational Safety and Health Act (OSHA):

1. OSHA 1910.144, Safety Color Code for Marking Physical Hazards.
2. OSHA 1910.145, Specifications for accident prevention signs and tags.

G. SSPC: The Society for Protective Coatings, (SSPC)

1. SSPC PA1 - Shop, Field, and Maintenance Painting of Steel
2. SSPC-PA2 – Paint Application Specification No. 2: Measurement of Dry Coating Thickness with Magnetic Gages.
3. SSPC-PA11 - Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
4. SSPC-SP1 Solvent Cleaning
5. SSPC-SP2 Hand Tool Cleaning
6. SSPC-SP3 Power Tool Cleaning
7. SSPC-SP5/NACE No. 1 – White Metal Blast Cleaning
8. SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning.
9. SSPC-SP 10/NACE No. 2 - Near-White Metal Blast Cleaning.
10. SSPC-SP 13/NACE No. 6 – Surface Preparation of Concrete
11. SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
12. SSPC-VIS 1 - Guide to Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

H. Unless otherwise specified, references to documents shall mean the documents in effect at the time of receipt of Bids. If referenced documents have been discontinued by the issuing organization references

to those documents shall mean the replacement documents or the last version of the document before it was discontinued.

1.3 DEFINITIONS

A. "Paint" as used herein means all coating systems, materials, including primers, emulsions, enamels, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

B. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils.

C. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter per pounds per gallon, as determined by EPA Method 24.

D. The term “exposed” as used in this Section shall mean all items not covered with concrete, masonry, or similar material.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

1. Submit to the Engineer as provided in the General Conditions and Section 013300: Contractor Submittals, Working Drawings, and Samples; shop drawings, manufacturer's specifications and data on the proposed paint systems and detailed surface preparation, application procedures and dry film thickness (DFT).
2. Submit material manufacturer's technical information, including paint label analysis and application instructions for each material proposed

    a. List each material and cross-reference to specific paint and finish system and application. Identify by manufacturer's catalog number and general classification.
    b. Submit copies of manufacturer's complete color charts for each coating system.
    c. Provide certifications from manufacturers verifying that factory applied prime coats are compatible with specified finish coatings.
    d. Pipe Markers and Safety Signs: Submit copies of manufacturer's technical brochure, including color chart and list of standard signs. Owner will set titles on pipe markers and safety signs.

B. Safety Data Sheets: Copies of current Safety Data Sheets (SDS) for materials.

C. Qualification Data: Submit proof of acceptability of Applicator by manufacturer to Engineer.

D. Jobsite Reports: Submit at the completion of Work
1. Daily Reports: Include surface preparation, ambient conditions, application methods, material applied, material quantities, material batch number, and description of items completed.
2. Applicator shall maintain a copy of records until the expiration of the specified warranty period.

E. Schedule:

1. The Contractor shall submit for approval to the Construction Manager, a complete typewritten Schedule of Painting Operations within 90 days after the Notice to Proceed. This Schedule is

imperative so that the various fabricators or suppliers may be notified of the proper shop prime coat to apply. It shall be the Contractor's responsibility to properly notify and coordinate the fabricator's or suppliers' surface preparation and painting operations with these specifications. Record of notification shall be transmitted to the Construction Manager or be available for review. This Schedule shall include for each surface to be painted, the brand name, generic type, solids by volume, application method, the coverage and the number of coats in order to achieve the specified dry film thickness, and color charts. When the Schedule has been approved, the Contractor shall apply all material in strict accordance with the approved Schedule and the manufacturer's instructions. Wet and dry paint film gauges may be utilized by the Owner to verify the proper application while work is in progress.

2. It is the intent of this section that as much as possible all equipment and piping utilize coating systems specified herein supplied by a single manufacturer. All exceptions must be noted on the Schedule. For each coating system, only one (1) manufacturer's product shall be used.
3. Contractor is responsible for the compatibility of all shop primed and field painted items in this Contract. Furnish information on the characteristics of the finish materials proposed to use, to ensure that compatible prime coats are used. As directed by the Engineer, provide barrier coats over incompatible primers or remove and re-prime. Notify the Engineer in writing of anticipated problems using the coating systems as specified with substrates primed by others.

F. Color Samples: Manufacturer's standard color charts for color selection by Owner.

G. Samples – Painting:

1. Paint colors will be selected by Owner unless other standards are noted. Compliance with all other requirements is the exclusive responsibility of the Contractor.

H. Applicator Qualifications: Submit qualifications as specified under Quality Assurance article.

I. Closeout Submittals:

1. Submit certificate stating Work was properly prepared and painted in accordance with Specifications.
2. Submit manufacturer's certificate stating quantity of paint furnished was sufficient to properly coat all surfaces.
3. Maintenance Manual: Upon completion of work, furnish copies of a detailed maintenance manual including following information:

a. Product name and number.
b. Name, address and telephone number of manufacturer and local distributor.
c. Detailed procedures for routine maintenance and cleaning.
d. Detailed procedures for light repairs such as dents, scratches and staining.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

A. Provide the best quality grade of the various types of coatings suitable for use in corrosive water and wastewater treatment and pumping environments as regularly manufactured by approved paint materials manufacturers. Materials not displaying the manufacturer's identification as a standard, best grade product will not be acceptable.

B. Provide undercoat paint produced by the same manufacturer as the finish coats. Undercoat and finish coat paints shall be compatible. Use only thinners approved by the paint manufacturer and list the manufacturer, and use only within recommended limits as listed on the manufacturer's product data sheets.

C. Painting shall be accomplished by experienced painters specializing in industrial painting familiar with all aspects of surface preparations and applications required for this project. Work shall be done in a safe and workmanlike manner.

D. Applicator Qualifications:

1. Successfully painted water and wastewater utility installations for at least five (5) years. Submit name and experience record of painting applicator to Engineer. A list of at least five (5) utility installations painted within the last five (5) years, along with responsible officials, architects or engineers involved with the project, and the approximate contract price may be requested by the Owner or Engineer.
2. Painting applicators whose submissions indicate a lack of experience required to perform the work, or have performed work in an unsatisfactory manner, will not be approved.

E. Pre-Installation Conference:

1. Before start of Work – General Contractor, Applicator, and Manufacturer's Technical Representative shall meet on-site with Engineer to discuss approved products and workmanship to ensure proper surface preparation and application of the coatings.
2. Review foreseeable methods and procedures related to the coating Work including but not necessarily limited to the following:

    a. Review Project requirements and the Contract Documents.
    b. Review required submittals.
    c. Review requirements of on-site quality control inspection and testing.
    d. Review the requirements for preparing the quality control report as specified herein.
    e. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
    f. Review material storage and staging.
    g. Review equipment storage and staging.
    h. Review waste management and disposal.
    i. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
    j. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
    k. Review procedures required for the protection of the completed work during the remainder of the construction period.

F. Single-Source Responsibility:

1. Materials shall be products of a single manufacturer or items standard with manufacturer of specified coating materials.
2. Provide secondary materials which are produced or are specifically recommended by coating system manufacturer to ensure compatibility of system.

G. Regulatory Requirements: Conform to applicable codes and ordinances for flame, fuel, smoke and volatile organic compounds (VOC) ratings requirements for finishes at time of application.

H. Acceptable Manufacturers:

1. Tnemec Co. (Where noted otherwise in the coating specification use specified product or equal).
2. Sherwin Williams
3. Or Equal. No substitutions will be considered that decrease film thickness, number of coats, surface preparation or generic type of coating specified. Furnish same color selection of substituted manufacturers as manufacturer specified, including accent colors in coating systems. Substitutions must meet the performance requirements of the materials selected.

1.7 DELIVERY, HANDLING AND STORAGE

A. Deliver, store and handle paint in accordance with manufacturer's recommendations, and as supplemented below.

B. Delivery of Materials:

1. Deliver materials to job site in original, new, and unopened packages and containers bearing manufacturer's name and label with following information:

a. Name or title of material.
b. Manufacturer's stock number, batch number and date of manufacture (shelf life).
c. Manufacturer's name.
d. Contents by volume, for major pigment and vehicle constituents.
e. Thinning instructions where recommended.
f. Application instructions.
g. Color name and number.

C. Storage of Materials:

1. Store only acceptable project materials on project site.
2. Store in a suitable location approved by Owner. Keep area clean and accessible.
3. Restrict storage to paint materials and related equipment.
4. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970. Flammable materials shall be separated and stored in a suitable area as required.
5. Keep temperature of storage area above 50° F or manufacturer's recommended storage temperature, whichever is higher. Consult the manufacturer’s written literature for storage condition requirements.
6. Containers shall be clearly marked to indicate any hazards connected with the use of the paint and steps which should be taken to prevent injury to those handling the product.

1.8 JOB CONDITIONS

A. Environmental Requirements:

1. Proceed with coating Work only when temperature of substrate, air temperature, relative humidity, dew point and other conditions comply with the manufacturer's written recommendations and when no damaging environmental conditions are forecasted for the time when the material will be vulnerable to such environmental damage. Record such conditions and include in Daily Report.
2. Maintain substrate temperature and ambient temperature before, during and after installation in accordance with manufacturer's instructions.
3. Provide adequate ventilation during installation and full curing periods of the coating.
4. Coatings shall not be applied when ambient air temperature is within 5°F of the dew point and falling.

B. Dust and Contaminants: Protect work and adjacent areas from excessive dust and airborne contaminates during coating application and curing. Schedule Work to avoid excessive dust and airborne contaminants.

1.9 WARRANTY AND GUARANTEES

A. All paint and coatings work performed under these specifications shall be guaranteed by the coatings applicator for 100 percent of the total coated area for both materials and labor against failures during the warranty period.

B. Failure under this warranty shall include flaking, peeling, or delaminating of the coating due to aging, chemical attack, or poor workmanship; but it shall not include areas which have been damaged by unusual chemical, thermal, or mechanical abuse.

1.10 SURFACES TO BE COATED

A. Design Requirements:

1. Ensure surfaces are properly prepared, proper primer applied to correct mil thickness, and finish coat is compatible with primer coat and applied to correct mil thickness. This requirement applies to all equipment and material, whether the total process is done in the shop, in the field, or partially in shop and partially in field.
2. Provide paint products supplied by one manufacturer unless otherwise approved by the Engineer.

B. Paint all exposed surfaces, except where natural finish of material is specifically noted as a surface not to be painted.

C. Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas.

D. The following items will not be painted unless otherwise noted.

1. Any code-requiring labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.

2. Any moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motor and fan shafts, unless otherwise indicated.
3. Aluminum except where in contact with dissimilar metals.
4. Fiberglass items including but not limited to handrails, walkways, toeboards, windows, louvers, fans, grating, and tanks.
5. Stainless steel, chromium plate/polished chrome, anodized aluminum, nickel and similar finished products.
6. Brass and bronze other than exposed utility tubing.
7. Flexible couplings, lubricated bearing surfaces, insulation and plastic pipe or duct interiors.
8. Plastic switch plates and receptacle plates.
9. Signs and nameplates.
10. Finish hardware.
11. Packing glands and other adjustable parts, unless otherwise indicated.
12. Portions of metal, other than aluminum, embedded in concrete. This does not apply to the back face of items mounted to concrete or masonry surfaces which shall be painted before erection. Aluminum to be embedded in, or in contact with, concrete shall be coated to prevent electrolysis.
13. Galvanized metals unless specifically noted otherwise.
14. Prefinished Items.

    a. Unless otherwise shown or specified, factory finishing such as baked-on factory porcelain, polyvinyl fluoride or other similar finish is specified for such items as, but not limited to, mechanical and electrical equipment such as instruments, light fixtures and distribution cabinets. Touch up factory finished items with paint supplied by the item manufacturer. As directed by Engineer, field paint damaged prefinished items or return them to the factory for repair and repainting.
    b. Any prefinished item not having generic type of paint or proper mil thickness to withstand corrosive atmosphere of water treatment plants, wastewater treatment plants and/or pumping stations shall be returned to the factory for painting or shall have additional coats applied in the field.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The following coating systems list a product by name to establish a standard of quality; other products of the same generic types may be submitted to the Engineer for approval as described in Paragraph 1.6 H., herein. When other than the specified coating system is proposed, the Contractor shall submit on a typewritten list giving the proposed coatings, brand, trade name, generic type and catalog number of the proposed system and the requested test results for the Engineer's approval.

B. Paint used in successive field coats shall be produced by the same manufacturer. Paint used in the first field coat over shop painted or previously painted surfaces shall cause no wrinkling, lifting, or other damage to underlying paint. Shop paint shall be of the same type and manufacturer as used for field painting by the Contractor.

C. Provide paints, pipe marker and safety signs of durable and washable quality. Use materials which will withstand normal washing as required to remove grease, oil, chemicals, etc., without showing discoloration, loss of gloss, staining, or other damage.

2.2 COLORS AND FINISHES

A. Provide surface treatments and finishes as specified in paragraph 2.4 of this Section.

B. Color Schedule: Colors for painted surfaces will be selected by Owner or as shown on Drawings.

C. Piping Color Code: Colors for piping will be in accordance with Section 220553 “Identification for Plumbing Piping and Equipment”.

D. Use representative colors when preparing samples for Engineer's review. Final acceptance of colors will be from samples applied on the job.

E. Color Pigments: Pure, nonfading, applicable types to suit substrates and service indicated.

F. Paints specified for application on submerged metal in contact with potable water shall meet NSF 61 and be approved by the governing health and safety codes.

2.3 MANUFACTURERS

A. Products of Tnemec Company, Inc., Kansas City, Missouri are listed to establish a standard of performance and quality.

B. Materials specified are those that have been evaluated for the specific service. Request for material substitutions shall be in accordance with the requirements of the project specifications. Equivalent materials of other manufacturers may be submitted on written approval of the Engineer. No request for substitution shall be considered that would decrease film thickness or offer a change in the generic type of coating specified. In no case, will the request be considered unless information is received, in writing, ten (10) days prior to the bid opening date.

C. Requests for substitution shall include:
   1. Manufacturer’s literature for each product giving name, product number, generic type, descriptive information, laboratory testing showing results equal to the performance criteria of the products specified herein.
   2. Side by side comparison of the performance attributes of the proposed materials as compared to the specified coating system.
   3. List of ten (10) projects in which each product has been used and rendered satisfactory service.
   4. The sum which will be added to or deducted from the base bid should alternate materials be accepted.

2.4 MATERIALS

A. STEEL – STRUCTURAL, TANKS, PIPE AND EQUIPMENT

1. SYSTEM 101 - EXTERIOR EXPOSED – STRUCTURAL, TANKS, AND EQUIPMENT

   a. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils
   b. Primer: Hydro-Zinc Series 94-H20 at 2.5 – 3.5 mils dft
   c. Intermediate: Hi-Build Epoxoline II V69 at 3.0 – 5.0 mils dft
   d. Finish: Finish: Endura-Shield II Series at 1075 2.0 to 3.0 mils dft

2. SYSTEM 102 - EXTERIOR EXPOSED – PIPE

    a. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils
    b. Primer: Hi-Build Epoxoline II V69 at 3.0 – 5.0 mils dft
    c. Intermediate: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
    d. Finish: Finish: Endura-Shield II Series 1075 at 2.0 to 3.0 mils dft

3. SYSTEM 103- INTERIOR EXPOSED

    a. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning with a minimum angular anchor profile of 1.5 mils
    b. Primer: Hi-Build Epoxoline II V69 at 3.0 – 5.0 mils dft
    c. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

4. SYSTEM 104 - IMMERSION – TYPICAL MUNICIPAL WASTEWATER

    a. Surface Preparation: SSPC-SP10 Near White Blast Cleaning with a minimum angular anchor profile of 1.5 mils
    b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
    c. Intermediate: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
    d. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

5. SYSTEM 105 - IMMERSION – POTABLE WATER REQUIRING NSF 61 CERTIFICATION
    a. N/A

6. SYSTEM 106 - IMMERSION – MODERATE TO SEVERE CHEMICAL EXPOSURE INCLUDING H_2S VAPOR EXPOSURE – SMALL STRUCTURES - MECHANISMS

    a. Surface Preparation: SSPC-SP10 Near-White Blast Cleaning with a minimum angular anchor profile of 2.0 mils
    b. Primer: Tneme-Liner Series 61 at 10.0 – 12.0 mils dft
    c. Finish: Tneme-Liner Series 61 at 10.0 – 12.0 mils dft

7. SEVERE WASTEWATER H_2S VAPOR EXPOSURE – LARGE STRUCTURES

    a. N/A

8. SYSTEM 107 - BELOW GRADE

    a. Steel Surface Preparation: SSPC-SP10 Near White Blast Cleaning
    b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
    c. Intermediate: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
    d. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

9. SYSTEM 108 – MARGINALLY PREPARED SURFACES (MAINTENANCE) (NON-IMMERSION) INTERIOR/EXTERIOR

    a. Surface Preparation: SSPC-SP2/SP3 Hand and Power Tool Cleaning, feather all rough edges, remove loose rust, dirt, and other surface contaminants with sandpaper, scotch brite, etc.

b. Primer: Chem-Build Series 135 3.0 to 5.0 mils dft
c. Interior Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
d. Exterior Finish: Endura-Shield II Series 1075 at 2.0 to 3.0 mils dft

B. FACTORY PRIMED STEEL – DOORS, FRAMES & EQUIPMENT

1. SYSTEM 121 - CHEMICAL EXPOSURE

a. Surface Preparation: SSPC-SP2/SP3 Hand and Power Tool Cleaning, feather all rough edges, remove loose rust, dirt, and other surface contaminants with sandpaper, scotch brite, etc.
b. Primer: Chem-Build Series 135 at 3.0 to 5.0 mils dft
c. Finish: Endura-Shield II Series 1075 at 2.0 to 3.0 mils dft

2. SYSTEM 122 - NON-CHEMICAL EXPOSURE

a. Surface Preparation: Clean & Dry
b. Primer: Enduratone Series 1028 at 2.0 – 3.0 mils dft
c. Finish: Enduratone Series 1028 at 2.0 – 3.0 mils dft

C. GALVANIZED STEEL, STAINLESS STEELS, & NON- FERROUS METALS

1. SYSTEM 201 – INTERIOR/EXTERIOR EXPOSED PIPE & MISC. FABRICATIONS

a. Surface Preparation: SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals to achieve a uniform anchor profile of 1.0 – 2.0 mils
b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
c. Interior Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
d. Exterior Finish: Endura-Shield II Series 1075 at 2.0 to 3.0 mils dft

2. SYSTEM 202 –IMMERSION PIPE & MISC. FABRICATIONS

a. Surface Preparation: SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals to achieve a uniform anchor profile of 1.0 – 2.0 mils
b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
c. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

3. SYSTEM 203 –DISSIMILAR METAL INSULATION – ALUMINUM IN CONTACT WITH CONCRETE, STAINLESS IN CONTACT WITH CARBON STEEL.

a. Surface Preparation: SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals to achieve a uniform anchor profile of 2.0 – 3.0 mils
b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
c. Intermediate: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
d. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

4. SYSTEM 204 – INTERIOR DRY EXPOSED – OVERHEAD DECKING AND DUCT WORK

a. Surface Preparation: Clean and Dry
b. Prime: Uni-Bond DF Series 115 at 2.0 – 4.0 dft mils
c. Finish: Uni-Bond DF Series 115 at 2.0 – 4.0 dft mils

D. DUCTILE OR CAST IRON – PIPE, PUMPS & VALVES

1. SYSTEM 211 - BELOW GRADE

a. Ductile Iron Surface Preparation: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.
b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
c. Intermediate: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
d. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

2. SYSTEM 212 –EXTERIOR EXPOSED (OUTSIDE DIAMETER)

a. Surface Preparation of Ductile Iron: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.
b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
c. Intermediate: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
d. Finish: Endura-Shield Series 1075 2.0 to 3.0 mils dft

3. SYSTEM 213 – INTERIOR EXPOSED AND/OR IMMERSION (OUTSIDE DIAMETER)

a. Surface Preparation of Ductile Iron: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.
b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
c. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

4. INTERIOR EXPOSED AND/OR IMMERSION, H_2S VAPOR EXPOSURE (INSIDE DIAMETER)

a. N/A

E. PVC

1. SYSTEM 221 - EXTERIOR EXPOSED

a. Surface Preparation: Scarify, Clean and Dry
b. Primer: Hi-Build Epoxoline II V69 at 2.0 – 4.0 mils dft
c. Finish: Endura-Shield Series 1075 at 2.0 to 3.0 mils dft

2. SYSTEM 222- INTERIOR EXPOSED

a. Surface Preparation: Scarify, Clean and Dry
b. Primer: Hi-Build Epoxoline II V69 at 2.0 – 4.0 mils dft
c. Finish: Hi-Build Epoxoline II V69 at 2.0 – 4.0 mils dft

F. CONCRETE & MASONRY –PRECAST, POURED-IN-PLACE, CAST-IN-PLACE AND CMU

1. SYSTEM 301 – INTERIOR WALLS NON-CHEMICAL EXPOSED

    a. Surface Preparation: SSPC-SP13/NACE 6 – Clean & Dry
    b. Filler for Porous Surfaces: Epoxoblock WB Series 1254 at 75 – 150 sq. ft./gal
    c. Primer: Enduratone Series 1028 at 2.0 – 3.0 mils dft
    d. Finish Enduratone Series 1028 at 2.0 – 3.0 mils dft

2. SYSTEM 302 - INTERIOR WALLS CHEMICAL EXPOSED

    a. Surface Preparation: SSPC-SP13/NACE 6 – Clean & Dry
    b. Filler (if needed): Epoxoblock WB Series 1254 at 75 – 150 sq. ft./gal
    c. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
    d. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

3. ULTRAFILTRATION TANKS – MEMBRANE BASINS – NSF61 POTABLE WATER

    a. N/A

4. SYSTEM 306 – BELOW GRADE OR IMMERSION

    a. Surface Preparation: SSPC-SP13/NACE 6, ICRI CSP 3
    b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
    c. Intermediate: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
    d. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

5. SEVERE WASTEWATER H_2S VAPOR EXPOSURE

    a. See Section 099657 for full specification

G. CONCRETE FLOORS

1. SYSTEM 311– LIGHT TRAFFIC, MILD CHEMICAL EXPOSURE

    a. Surface Preparation: SSPC-SP13/NACE 6, Minimum ICRI CSP-2
    b. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
    c. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

2. SYSTEM 312 – DRY AREAS – WAREHOUSE STORAGE

    a. Surface Preparation: Clean and Dry – as per product data sheet
    b. Finish: CT Densifyer Series 629 at 300 – 350 square feet per gallon

3. RESINOUS FLOORING

    a. N/A

H. CONCRETE – SECONDARY CONTAINMENT

1. N/A

I. WALLS

1. SYSTEM 401 - GYPSUM WALL BOARD - INTERIOR

   a. Prime: Elasto-Grip FC Series 151-1051 at 0.7 – 1.5 mils dft
   b. Intermediate: Enduratone Series 1028 at 2.0 – 3.0 mils dft
   c. Finish: Enduratone Series 1028 at 2.0 – 3.0 mils dft

2. SYSTEM 402 - WALL BOARD – WATER RESISTANT – INTERIOR WALLS CHEMICAL EXPOSURE

   a. Surface Preparation: Clean & Dry
   b. Surfacer/Filler for joints and screw holes: Surfacing Epoxy Series 215 and Series 273 Part D fiberglass tape
   c. Primer: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft
   d. Finish: Hi-Build Epoxoline II V69 at 4.0 – 6.0 mils dft

J. WOOD

1. SYSTEM 411 - INTERIOR

   a. Surface Preparation: Sand rough areas. Clean and dry.
   b. Prime: Elasto-Grip FC Series 151-1051 at 0.7 – 1.5 mils dft
   c. Intermediate: Enduratone Series 1028 at 2.0 – 3.0 mils dft
   d. Finish: Enduratone Series 1028 at 2.0 – 3.0 mils dft

K. MISCELLAENOUS

1. SYSTEM – 601- EXPOSED SAWCUT CONCRETE FACE AND EXPOSED REINFORCEMENT

   a. Surface Preparation: According to manufacturer's recommendations.
   b. Coating: Sika Armatec 110 EpoCem, or equal (Coverage per manufacturer's recommendations. Minimum 20 mil. thickness).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

C. Remove by blast cleaning to SSPC-SP 10 Near White Blast Cleaning any bitumastic coating or improper primer on any material or equipment which is to be painted and arrives at the construction site with a bitumastic coating or a priming system not specified in paragraph 2.4 Coating Systems.

3.2 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

C. Remove mask, or otherwise protect hardware, lighting fixtures, switchplates, machines, surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting. Mask openings in motors and equipment to prevent abrasives, paint and other materials from entering.

D. Exercise care not to damage adjacent work during sandblasting operations. Conduct spray painting under controlled conditions. Promptly repair any damage to adjacent work or adjoining property occurring from sandblasting or spray-painting operations.

3.3 SURFACE PREPARATION

A. Surfaces shall be prepared in accordance with manufacturer's written instructions as outlined in the product data sheet and application guides.

1. Surface preparation shall be as specified in the designated coating system.

B. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

C. Steel – Structural, Tanks, Pipe and Equipment:

1. Grind smooth to a rounded contour sharp edges and welds, and remove weld splatter.
2. Prior to the specified surface preparation SSPC-SP1 Solvent Cleaning shall be performed to all surfaces.
3. SSPC-SP2 Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.
4. SSPC-SP3 Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.
5. SSPC-SP5/NACE 1 White Metal Blast Cleaning: Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.
6. SSPC-SP6/NACE 3 Commercial Blast Cleaning: Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each 9-square inch of surface area.
7. SSPC-SP10/NACE 2 Near-White Blast Cleaning: Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each 9-square inch of surface area.
8. Apply prime coat before rust bloom forms or within 24-hours, whichever is earlier.
9. Do not allow blast cleaned or bare surfaces to stand overnight before coating.

D. Ductile or Cast Iron – Pipe, Pumps, Valves and Fittings

1. Ductile iron pipe and fittings shall be delivered without asphalt, cement lining, or any other lining.
2. All oils, small deposits of asphalt paint, grease, and soluble deposits shall be removed in accordance with NAPF 500-03-01 Solvent Cleaning prior to abrasive blasting.
3. Exterior Preparation: Uniformly abrasive blast the entire exterior surface using angular abrasive to an NAPF 500-03-04: "External Pipe Surface Condition". When viewed without magnification, the exterior surfaces shall be free of all visible dirt, dust, loose annealing oxide, loose mold coating, rust and other foreign matter. Tightly adherent annealing oxide, mold coating and rust staining may remain on the surface provided they cannot be removed by lifting with a dull putty knife. Any area where rust reappears before application shall be re-blasted. The surface shall contain a minimum angular anchor profile of 1.5 mils in accordance with ASTM D 4417, Method C.

E. Galvanized Steel, Aluminum, Stainless Steel, and Non-Ferrous Metal Substrates:

1. SSPC-SP16 Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals: Not for carbon steel. Requires sweep blasting of the entire surface to remove all foreign matter. Dense and uniform surface profile is required.
2. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions.

F. Wood Substrates:

1. Wood surfaces to be painted shall be cleaned of dirt, oil or other foreign substances with mineral spirits, scrapers, sandpaper or wire brush. Seal knots and pitch pockets with shellac reduced with equal parts of shellac thinner (denatured alcohol) before sandpaper finishing with fine grit and remove sanding dust. After the prime coat is dry, fill cracks and holes with putty or spackling compound. When filler is hard, sand flush with the surface using fine grit sandpaper. Sand lightly between coats with fine grit, open-coated sandpaper.

G. PVC Substrates:

1. PVC surfaces to be painted shall be clean, dry and free of oil, grease, and other contaminants and lightly sanded to create a surface for coating to adhere to.

H. Concrete and Masonry Substrates:

1. All surfaces must be clean, dry and free of oil, grease and other contaminants, prior to preparation in accordance with NACE No. 6/SSPC-SP13. Concrete surfaces must be sound and capable of supporting the coating system.
2. Prepare concrete surfaces in accordance with NACE No. 6/SSPC-SP13 Joint Surface Preparation Standards and ICRI Technical Guidelines. Shot-blast or mechanically abrade concrete surfaces to remove laitance, curing compounds, hardeners, sealers, existing coatings, and other contaminants and to provide the recommended ICRI-CSP Profile.
3. Cracks, voids and other surface imperfections should be filled with the recommended filler or surfacer prior to the installation of the materials.
4. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through the coating system according to manufacturer's written recommendations.

5. Level or grind concrete substrates to produce a uniform and smooth surface, including removal of sharp edges, ridges, form fins, and other concrete protrusions.
6. All surfaces to be painted or repainted, shall be repaired, cleaned and finished to the standards as specified herein and in Division 3 for new concrete.

I. Gypsum Drywall:
1. Sand joint compound with fine grit, open-coated sandpaper to provide a smooth flat surface. Avoid heavy sanding of the adjacent wall board surfaces, which will raise the nap of the paper covering. Remove dust from the surface by wiping with clean rags or other means. If additional joint finishing is required to provide a smooth surface, the same joint compound of a ready-mixed spackling compound should be used. Putty, patching pencils, caulking or masking tape should not be applied to dry wall surfaces to be painted. Finish level 4 or 5 must be achieved prior to beginning to paint. Level shall be suitable for coating system to be applied.
2. Lightly scuff-sand tape joints after priming to remove raised paper nap. Take care not to sand through the prime coat and remove dust by wiping with clean rags.

3.4 APPLICATION

A. Apply coatings in accordance with manufacturer's written instructions as outlined in the product data sheet, application guides and technical bulletins.

B. The application of coatings to steel substrates shall be in accordance with SSPC PA1 - Shop, Field, and Maintenance Painting of Steel.

C. All painting shall be done by skilled and experienced craftsmen and shall be of highest quality workmanship. Coating systems shall be as specified herein.

D. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer’s instructions.

E. Uniformly apply coatings at spreading rate required to achieve specified Dry Film Thickness (DFT).

F. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems

G. Paint back sides of access panels and removable or hinged covers to match the exposed surfaces.

H. Equipment manufacturer or supplier shall provide touch-up paint for items with shop applied finish coats.

I. Where specified in the individual sections, primer coat(s) shall be applied in the shop by the equipment manufacturer. The shop coats shall be as specified and shall be compatible with the field coat or coats.

J. Certification: The Contractor shall obtain from the equipment manufacturer or supplier, prior to shipment of equipment, a written certification that surface preparation, coating brand, material, DFT and application method complied with this section.

K. If the shop applied coating is in good condition, as determined by the Engineer, the field application may consist of touching up the shop primer coat to achieve the specified film thickness in accordance with the product data sheet.

1. The Owner/Engineer reserves the option, however, to require that badly damaged and poorly applied shop coatings be removed and the surfaces recoated in accordance with the specified system requirements.

L. Shop applied coatings of unknown composition shall be completely removed before the indicated coatings are applied.

1. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. If present, this coating shall be removed.

M. Shop primed equipment shall be prepared as per manufacturer's recommendations in the field before finish coats are applied.

N. Shop Applied Bituminous Paint or Asphalt Varnish: Abrasive blast clean shop applied bituminous paint or asphalt varnish from surfaces scheduled to receive non-bituminous coatings.

O. In accordance with SSPC-PA11 Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating shall be applied to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present.

P. Each coat of paint shall be of a slightly different shade, to facilitate inspection of surface coverage of each coat.

Q. Sprayed Finishes: Spray paint finish doors, frames and windows, where required. Brush or roller finishes will not be acceptable.

R. Install piping markers and safety signs only after painting and finish work is completed.

3.5 FIELD QUALITY CONTROL, INSPECTION AND TESTING

A. The Applicator shall perform the quality control procedures listed below in conjunction with the requirements of this section.

B. Inspect materials upon receipt to ensure that products are supplied by the approved Manufacturer.

C. Surface Profile and Degree of Surface Cleanliness: Inspect and record substrate profile (anchor pattern) and degree of cleanliness. Surfaces shall meet the manufacturer's recommended anchor profile and degree of blast cleaning.

1. Visually confirm the specified degree of surface cleanliness of the ferrous metal surface in accordance with SSPC-VIS 1.
2. The specified surface profile of the prepared substrate shall be verified in accordance with ASTM D4417 – Method C Replica Tape or NACE RP0287.

D. Concrete Surface Profile: Inspect and record substrate profile. Surface profile shall be equal to the manufacturer's recommendation in accordance with ICRI Guideline 310.2 and SSPC-SP13/NACE No. 6.

1. Compare the substrate profile once every 50 square feet with the Concrete Surface Profile (CSP) comparators in accordance with ICRI Guideline No. 310.2.

E. Concrete Moisture Testing: After surface preparation verify concrete dryness in accordance with one or more of the following moisture tests.

1. ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

    a. Moisture vapor transmission not to exceed three pounds per 1,000 square feet in a 24-hour period.

2. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

    a. Relative humidity not to exceed 80 percent.

3. ASTM D4263— Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

    a. No moisture present.

4. Consult manufacturer regarding questions and or recommendations in reference to moisture problems or questions.

F. Surface Cleanliness: Prepared surfaces shall be inspected for surface cleanliness after cleaning and drying, prior to the coating application.

G. Measure and record ambient air temperature, relative humidity and dew point temperature once every two hours of each work shift to ensure that the products are being applied within the manufacturer's recommendations.

H. Measure and record substrate temperature once every two hours using an infrared or other surface thermometer to ensure that the products are being applied within the manufacturer's recommendations.

I. Film Thickness:

1. Wet-Film Thickness shall be taken every 100 square feet in accordance with ASTM D4414 or other agreed-upon method.
2. The Dry-Film Thickness (DFT) shall be measured in accordance with SSPC-PA2 Measurement of Dry Coating Thickness. Verify DFT of each coat and total DFT of each coating system are as specified.

J. Holiday (Spark) Testing: Upon full cure of coating system numbers 104, 105, and 106 the coating system shall be checked by spark detection in accordance with NACE SP0188 and the Manufacturer's instructions to verify a pinhole-free surface. Areas which do not pass the spark detection test shall be corrected at no cost to the Owner.

1. Submit written reports of the test results and actions taken to correct non-conforming work.

K. The Applicator is responsible for keeping the Engineer informed of progress so that Engineer may provide additional quality control at his discretion.

L. Inspection by the Engineer or others does not absolve the applicator from his responsibilities for quality control inspection and testing as specified herein or as required by the Manufacturer's instructions.

3.6 MANUFACTURER'S FIELD SERVICES

A. Manufacturer's technical representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.7 ACCEPTANCE CRITERIA

A. Surfaces shall be prepared, applied, and tested in accordance with the specification and referenced standards herein.

3.8 REPAIR

A. Damaged Materials: Repair or replace damaged materials and surfaces not scheduled to be coated.

B. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where the result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.9 PROTECTION AND CLEANING

A. Protect the completed Work from traffic, physical abuse, immersion and chemical exposure until the complete system has thoroughly cured as per manufacturer's written instructions.

B. At the completion of the Work, Applicator shall remove materials and debris associated with the Work of this Section.

C. Clean surfaces not designated to receive coating. Restore designated areas in a manner acceptable to Engineer.

D. Protect the completed Work from damage until Final Acceptance. Coating damaged in any manner shall be repaired or replaced at the discretion of Engineer, at no additional cost to Owner.

3.10 COATING/FINISH SCHEDULE

A. As shown in Drawings.

END OF SECTION 098000

SECTION 099000 - ARCHITECTURAL PAINT FINISHES

PART 1 – GENERAL

1.01 THE REQUIREMENT:

A. The Contractor shall prepare surfaces for painting and shall paint all surfaces not specifically included under the requirements of Section 098000 entitled, "Protective Coatings", as required or indicated on Drawings, all in accordance with the requirements of the Contract Documents.

B. Materials not to be painted hereunder shall include the following:

1. Work having complete factory finish other than prime coat.

2. Stainless steel, anodized aluminum, brass, bronze and plated finished metals designed and used for architectural trim.

3. Finish hardware except prime-coated items, fusible links, UL labels, nameplates, numbers and identifying data.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. Painting and coating intended for industrial purposes or protecting the coated surface from abrasion, wear, corrosion, oxidation, decomposition or other effects of exposure shall conform to the requirements of Section 098000 entitled, "Protective Coatings". For the purposes of definition, all surfaces listed in the coating system schedules of the Protective Coatings Section 098000, shall be deemed to be surfaces requiring such special coating, and in case of conflict between the provisions of the Protective Coatings section and the Architectural Paint Finishes specified herein, the provisions of the Section entitled, "Protective Coatings" shall take precedence.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS:

A. Codes: References herein to "Building Code" or CBC shall mean the 2016 edition of the California Building Code.

B. In case of conflict between codes, reference standards, drawings and these Specifications, the; most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and directions prior to ordering or providing any materials or labor.

1.04 CONTRACTOR SUBMITTALS:

A. At least thirty (30) days prior to painting operations the Contractor shall submit for acceptance, a complete list of all paint materials proposed for use, identifying each material by manufacturer's name, product name and number. The list shall include all primers, thinners and coloring agents, together with manufacturer's catalog data fully describing each material as to contents, recommended usage and preparation and application methods.

Color samples and stain samples shall also be submitted for color selection by the Engineer. Submittals shall conform to the provisions of Section entitled, "Contractor Submittals". Stain samples shall be provided on the same material as the stain will be applied in the final installation.

B. Upon completion of the project, the Contractor shall provide the Owner with one (1) new unopened gallon of each type and color of paint used on the project. The cost thereof shall be included as part of the work required under this Section.

1.05 QUALITY ASSURANCE:

A. The Contractor shall give the Engineer a minimum of three (3) days advance notice of the start of any field or shop surface preparation and painting application work. All such work shall be performed only in the presence of the Engineer, unless the Engineer has granted prior approval to perform such work in its absence. Inspection by the Engineer, or the waiver of inspection of any particular portion of the work, shall not relieve the Contractor of its responsibility to perform the work in accordance with these Specifications.

B. The painting sub-contractor must possess a valid State license as required for performance of the painting and coating work called for in this Specification and must provide five (5) references which show that the painting sub-contractor has previous successful experience with the specified painting systems. Include the name, address and telephone number of a responsible individual of each installation for which the painting sub-contractor provided the work.

C. The Contractor shall require the protective coating manufacturer to furnish a qualified technical representative to visit the project site for technical support as may be necessary to resolve field problems attributable or associated with the manufacturer's products furnished under this Contract or the application thereof.

D. A warranty inspection will be conducted during the eleventh (11th) month following application of each painting system. The Contractor and a representative of the coating material manufacturer may be called upon to attend this inspection. All defective work shall be repaired in accordance with these Specifications and to the satisfaction of the Owner. The Owner may, by written notice to the Contractor, reschedule or cancel the warranty inspection. If the warranty inspection is not held, the Contractor is not relieved of its responsibility under the Contract Documents.

PART 2 – PRODUCTS

2.01 GENERAL:

A. The paint materials shall be delivered to the job site sealed in containers that plainly show the manufacturer's name, product class, manufacturer's code, color, date of manufacture, hazardous ingredients and flammability classification, extinguishing media and fire fighting procedures, health hazard data and emergency first aid procedures.

B. Stored paints, thinning agents and solvent shall be kept covered and precautions shall be taken for the prevention of fire. Empty containers and paint-soiled or oily rags shall be

removed from the site at the end of each day's work. Paint thinner shall not be stored in a room scheduled to receive resilient flooring.

C. Unless otherwise approved paint materials shall be from the catalogs of the companies listed herein. Materials by other manufacturers are acceptable provided that they are established as being compatible with and of equal quality to the coatings of the companies listed. In accordance with the requirements of the Supplemental General Conditions Section entitled, "Contractor Submittals", the Contractor shall provide satisfactory documentation from the firm manufacturing the proposed substitute or "or equal" material that their product meets the specified requirements and is equivalent or better than the listed materials. The cost of all testing and analyzing of the proposed substitute materials that may be required by the Engineer shall be paid by the Contractor. If the proposed substitution requires changes in the Contract work, the Contractor shall bear all such costs involved and the costs of allied trades affected by the substitution.

D. All finish colors shall be as selected or specified by the Engineer from the manufacturer's color samples.

2.02 ARCHITECTURAL PAINT SYSTEMS:

A. Vinyl Acrylic Latex Interior Wall and Ceiling Finish: Premium quality vinyl acrylic latex coating with minimum solids content of thirty-two percent (32%) by volume.

1. Primer-Sealer Drywall, Wood or Masonry: (DFT = 2.0 mils)
Carboline: Sanitile 120, or Equal

2. Finish Coats (two or more) (DFT = 3 mils)
Carboline: Carbocrylic 3359 (Semi-Gloss)

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS:

A. Unless otherwise specified, all architectural paint materials shall be applied by brush or roller in strict accordance with the manufacturer's printed instruction. The manufacturer's recommended amount of thinner shall not be exceeded. Unless otherwise approved, finish coat material shall be applied as taken from manufacturer's container. Spray painting is only allowed on metal doors primed and painted in a shop setting. Each coat shall be applied at proper consistency and shall be free of brush or roller marks, sags, runs or any other evidence of poor workmanship. The splattering of paint on glass, hardware, tile, trim and other surfaces not to be painted shall be avoided. Masking shall be applied as required. Floor, fixtures, equipment and similar surfaces shall be protected with impervious protective covers and/or drop cloths. The Contractor shall maintain barricades and wet paint signs for duration of period needed.

3.02 SURFACE PREPARATION:

A. General: The Contractor shall properly prepare surfaces to receive finishes as indicated and specified. Finish hardware shall be removed prior to painting and finishing and re-installed as specified.

B. Ferrous and Galvanized Metal: Ferrous metal surfaces shall be cleaned of rust, scale, grease, oil and other deleterious matter by wire brushing, scraping, washing with solvent, sandblasting or other means necessary to properly prepare surfaces for painting. Shop painted ferrous metal surfaces that show rusting when initially installed shall be touched up with a rust inhibitor approved by the Engineer. Galvanized metals shall be cleaned with suitable organic solvent.

3.03 APPLICATION:

A. No coating shall be applied under the following circumstances:

1. When the surrounding air temperature or the temperature of the surface to be coated is below 40 deg. F.;

2. When surfaces are too wet or damp, or in rain, fog or mist;

3. When the temperature is less than 5 deg. F. above the dewpoint; or

4. When it is expected the air temperature will drop below 40 deg. F., or less than 5 deg. F above the dewpoint within 8 hours after application of coating.

Dewpoint shall be measured by use of a sling psychrometer in conjunction with U. S. Department of Commerce Weather Bureau psychometric tables.

B. The Contractor shall apply complete paint system required for exposed surfaces behind permanent cabinets, cases, counters and similar work before such items are installed.

3.05 CLEANUP:

A. Upon completion of the work, all staging, scaffolding and containers shall be removed from the job site and disposed of in a manner approved by State and Local environmental regulations. Coating spots and oil or stain upon adjacent surfaces shall be removed and the job site cleaned. All damage to adjacent surfaces or facilities resulting from the work performed under the Contract shall be cleaned, repaired or refinished to the satisfaction of the Engineer at no additional cost to the Owner.

3.06 OUTLINE OF PAINTING AND FINISHING WORK:

A. Exterior: Where noted in drawings, all exposed exterior surfaces of the building shall be painted and finished in accordance with the requirement herein specified for paint materials and surfaces. Exposed surfaces of miscellaneous metal, sheet metal items, mechanical equipment and all other items, as required, shall be painted with the required primers and coats of paint, as per the building manufacturer.

B. Interior: Where noted in drawings, exposed surfaces of the building shall be painted and finished in accordance with the requirements herein specified for paint and finish materials and surface:

1. Surfaces of gypsum wallboard, plywood sheeting, and doors and frames shall be primed and painted as specified.

2. Metal items in partitions and ceilings such as registers, grilles and similar items shall be painted to match finish of room or area in which they occur, unless directed otherwise by the Engineer.

3. Painted doors opening into rooms or spaces having different finishes or colors shall have the edges finished as directed by the Engineer.

END OF SECTION 099000

SECTION 099657 - PROTECTIVE EPOXY LINER FOR STRUCTURES EXPOSED TO SEVERE WASTEWATER ENVIRONMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the surface preparation and application requirements by a qualified applicator for a high-build epoxy lining system for concrete to the interior surfaces of the structures identified in the Protective Coatings Schedule in drawings and specified herein. Including:

B. Coordination:

1. Coordinate surface preparation of substrates to avoid later difficulty or delay in performing the Work of this Section.
2. Review installation procedures under other Sections and coordinate the installation of items that must be installed prior to application of the protective lining.
3. Substrate surface preparation and lining application, including concrete resurfacing, to be completed by manufacturer's approved Applicator.
4. The Applicator shall coordinate with Engineer regarding the availability of work areas, completion times, safety, access and other factors which can impact plant operations.

C. Related Sections:

1. Section 013300, Contractor Submittals
2. Section 033000, Cast-in-Place Concrete
3. Section 33800, Precast Concrete Manholes and Vaults
4. Section 079200, Joint Sealants
5. Section 071400, Fluid-Applied Waterproofing

1.2 REFERENCES

A. Section contains references to the governing standards and documents listed below. They are a part of this Section as specified and modified; the current version shall apply unless otherwise noted. In case of conflict between the requirements of this section and those of the listed documents, the more stringent of the requirements shall prevail.

B. American Concrete Institute (ACI):

1. ACI 224 – Causes, Evaluation, and Repair of Cracks in Concrete Structures
2. ACI 301 – Specifications for Structural Concrete
3. ACI 308 – Guide to Curing Concrete

C. ASTM International (ASTM):

1. ASTM C307 – Standard Test method for Tensile Strength of Chemical Resistant Mortars, Grouts, and Monolithic Surfacings.
2. ASTM C413 – Standard Test Method for Absorption of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
3. ASTM C496 – Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
4. ASTM C531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
5. ASTM C579 – Standard Test Methods for Compressive Strength of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
6. ASTM C580 – Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
7. ASTM C596 – Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
8. ASTM C868 – Standard Test Method for Chemical Resistance of Protective Linings
9. ASTM C1583/1583M – 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).
10. ASTM D638 – Standard Test Method for Tensile Properties of Plastics
11. ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics
12. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
13. ASTM D1653 – Standard Test Methods for Water Vapor Transmission of Organic Coating Films.
14. ASTM D2370 – Standard Test Method for Tensile Properties of Organic Coatings
15. ASTM D2794 – Standard Test Method for Resistance of Organic Linings to the Effects of Rapid Deformation (Impact).
16. ASTM D4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
17. ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
18. ASTM D4417 – Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel.
19. ASTM D7234 – Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
20. ASTM D7682 – Standard Test Method for Replication and Measurement of Concrete Surface Profiles Using Replica Putty.
21. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials
22. ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
23. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

24. ASTM G210 – Standard Practice for Operating the Severe Wastewater Analysis Testing Apparatus (S.W.A.T.).

D. International Concrete Repair Institute (ICRI):

1. Guideline No. 310.1 – Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
2. Guideline No. 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealer, Linings, and Polymer Overlays

E. NACE International (NACE):

1. NACE RP0287 – Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
2. NACE SP0188 – Standard Practice for Discontinuity (Holiday) Testing of Protective Linings
3. NACE SP0892 – Standard Practice for Coatings and Linings over Concrete for Chemical Immersion and Containment Service
4. NACE No. 1/SSPC-SP 5 – White Metal Blast Cleaning
5. NACE No. 6/SSPC-SP13 – Surface Preparation of Concrete

F. National Association of Pipe Fabricators (NAPF)

1. NAPF 500-03 – Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings

G. SSPC: The Society for Protective Coatings, (SSPC)

1. SSPC-SP 1 - Solvent Cleaning
2. SSPC-SP 5/NACE No. 1 White Metal Blast Cleaning
3. SSPC-SP 13/NACE No. 6 Surface Preparation of Concrete
4. SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
5. SSPC-VIS 1 - Guide to Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

H. Unless otherwise specified, references to documents shall mean the documents in effect at the time of receipt of Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents, the last version of the document before it was discontinued.

1.3 SYSTEM DESCRIPTION

A. Protective Lining shall be comprised of the following materials:

1. Cementitious Repair Mortar: Rapid-setting, cementitious repair mortar when concrete is deteriorated greater than a depth of 1/4-inch and when recommended by the Manufacturer to rehabilitate and restore concrete and provide level

substrate for application of the protective lining; this product requires re-blasting prior to applying basecoat; or

2. Epoxy Cementitious Resurfacer: Epoxy-polymer modified cementitious resurfacer (thin overlay) applied to entire new or existing concrete surface to a depth up to 1/2-inch. Repair new or existing concrete to fill all bugholes, surface imperfections and provide a uniform, level substrate for application of the protective lining.
3. Aggregate Reinforced Epoxy Mortar Basecoat: Trowel applied basecoat shall provide a chemical, permeation, and abrasion resistant protective lining against physical and chemical attack associated with severe wastewater headspace conditions.
4. Epoxy Topcoat and Metal Coating: to provide enhanced chemical, permeation, and abrasion resistance.

B. The surfaces to receive the protective lining shall be capable of withstanding under constant exposure to raw wastewater, permeation from hydrogen sulfide and other sewer gases, and attack from organic acids generated by microbial sources with no adverse effects. Products must have sufficient field history and accelerated laboratory testing to substantiate product viability for these exposures.

1.4 SUBMITTALS

A. Product Data Sheets: Copies of current technical data for each component specified and applied as outlined in this Section.

B. Safety Data Sheets: Copies of current Safety Data Sheets (SDS) for any materials brought on-site, including all clean-up solvents, repair or resurfacing mortars and lining materials.

C. Installation Instructions: Manufacturer's written installation instructions for the materials specified in this Section.

D. Qualification Data:

1. Qualified Applicator Training Certificates from manufacturer.
2. Submit proof of acceptability of Applicator by manufacturer to Engineer.
3. Submit letter from manufacturer stating that the Applicator has successfully applied the corrosion protection lining system on projects of similar size and scope.
    a. List of references substantiating the projects.

E. Construction Details: Copies of manufacturer's computer generated standard lining details for specified materials, including: leading edge termination, metal embedment in concrete, joint detail, wall-to-slab detail, pipe termination detail, and any other detail at the request of the Engineer.

F. Jobsite Layout Plan: Including material storage/staging and equipment storage /staging.

G. Jobsite Reports: Submit at the completion of Work

1. Daily Reports: Include surface preparation, substrate conditions, ambient conditions application procedures, lining materials applied, material quantities, material batch number, description of work completed and location thereof.
2. Quality Control Reports: Include all quality control testing and physical specimens.
3. Applicator shall maintain a copy of records until the expiration of the specified warranty period.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Applicator shall be qualified by the manufacturer prior to bid date.
2. Installation equipment shall be acceptable to the manufacturer.
3. Applicator has successfully applied the corrosion protection lining system on projects of similar size and scope.
    a. List of references substantiating the projects.
4. Applicator shall establish quality control procedures and practices to monitor all phases of surface preparation, storage, mixing, application, and inspection throughout the duration of the project.
5. Applicator shall provide a fulltime, on-site person whose dedicated responsibilities will include quality control of the corrosion protection linings application.
6. Applicator's quality control procedures and practices must include the following items:
    a. Training of personnel in the proper surface preparation requirements.
    b. Training of personnel in the proper storing, mixing, and application and quality control testing of the linings.

B. Mock-Ups:

1. Prior to the installation of the corrosion protection lining and auxiliary system components, but after Engineer's approval of the Samples and Submittals, install 100 square foot stepped-back mock-ups of the systems showing surface preparation and each system component in an area selected by Engineer to show representative installation of the Work.
2. Engineer shall approve the mock-up before the start of Work.
3. Retain and protect mock-ups during construction as one standard for judging completed corrosion protection lining Work. Do not alter mock-ups after approval by Engineer.
4. Applicator shall build as many mock-ups as required to achieve Engineer's acceptance of the corrosion protection lining.
5. The approved mock-up shall be considered the acceptable minimum standard of quality.
6. Any corrosion protection lining Work that proceeds without approved mock-ups will not be accepted by the Engineer and removed at no cost to the Owner.

C. Pre-Installation Conference:

1. Before erecting mock-ups General Contractor, Applicator, and Technical Representative of the Manufacturer shall meet on-site with Engineer to discuss approved products and workmanship to ensure proper application of the corrosion protection lining components and substrate preparation requirements.
2. Review foreseeable methods and procedures related to the corrosion protection lining of coating Work including but not necessarily limited to the following:
    a. Review Project requirements and the Contract Documents.
    b. Review required submittals, both completed and yet to be completed.
    c. Review status of substrate Work, including approval of surface preparations and similar considerations.
    d. Review requirements of on-site quality control inspection and testing.
    e. Review the requirements for preparing the quality control report as specified herein.
    f. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
    g. Review material storage and staging.
    h. Review equipment storage and staging.
    i. Review waste management and disposal.
    j. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
    k. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.
    l. Review procedures required for the protection of the completed corrosion protection lining during the remainder of the construction period.

D. Single-Source Responsibility:

1. Materials shall be products of a single manufacturer or items standard with manufacturer of specified coating materials.
2. Provide secondary materials which are produced or are specifically recommended by coating system manufacturer to ensure compatibility of system.

E. Regulatory Requirements: Conform to applicable codes and ordinances for flame, fuel, smoke and volatile organic compounds (VOC) ratings requirements for finishes at time of application.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials:

1. Deliver material in manufacturer’s original, unopened and undamaged packages.
2. Clearly identify manufacturer’s, brand name, contents, color, batch number, and any personal safety hazards associated with the use of or exposure to the materials on each package.
3. Packages showing indications of damage that may affect condition of contents are not acceptable.

B. Storage of Materials:

1. Materials shall be stored in accordance with manufacturer's recommendations in enclosed structures and shall be protected from weather and adverse temperature conditions. Flammable materials shall be stored in accordance with state and local codes. Store all materials only in area or areas designated by the Engineer solely for this purpose.
2. Materials exceeding storage life as defined by the manufacturer shall be removed promptly from the site.
3. Store in original packaging under protective cover and protect from damage.
4. Stack containers in accordance with manufacturer’s recommendations.

C. Handling of Materials: Handle materials in such a manner as to prevent damage to products or finishes.

1.7 JOB CONDITIONS

A. Environmental Requirements:

1. Proceed with corrosion protection lining Work only when temperature and moisture conditions of substrates, air temperature, relative humidity, dew point and other conditions comply with the manufacturer’s written recommendations and when no damaging environmental conditions are forecasted for the time when the material will be vulnerable to such environmental damage. Record all such conditions and include in final Site Quality Control Report.
2. Maintain substrate temperature and ambient temperature before, during and after installation above 50°F in accordance with material manufacturer’s instructions.
3. Provide adequate ventilation during installation and full curing periods of the protective lining.
4. Protective Lining shall not be applied when ambient air temperature is within 5°F of the dew point and falling.

B. Dust and Contaminants: Protect work and adjacent areas from excessive dust and airborne contaminants during protective lining application and curing. Schedule Work to avoid excessive dust and airborne contaminants.

1.8 WARRANTY

A. Manufacturer shall warranty its products as free from material defects for a minimum period of three (3) years. Provide associated Warranty Certificate.

B. Applicator shall warranty the installed protective lining system as free from workmanship defects for a minimum period of three (3) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products of Tnemec Company, Inc., Kansas City, Missouri are listed to establish a standard of performance and quality. Local Representation: Call Coating Consultants, 801-282-2327, ccc@tnemec.com.

B. Acceptable manufacturers (subject to conformance to specifications):

1. Sherwin Williams

C. Materials specified are those that have been evaluated for the specific service. Request for material substitutions shall be in accordance with requirements of the project specifications. Equivalent materials of other manufacturers may be submitted on written approval of the Engineer. No request for substitution shall be considered that would decrease film thickness or offer a change in the generic type of coating specified. In no case, will the request be considered unless all information is received, in writing, ten (10) days prior to the bid opening date.

D. Requests for substitution shall include:

1. Manufacturer's literature for each product giving name, product number, generic type, descriptive information, laboratory testing showing results equal to the performance criteria of the products specified herein.
2. Side by side comparison of the performance attributes of the proposed materials as compared to the specified coating system.
3. List of ten (10) projects in which each product has been used and rendered satisfactory service.
4. The sum which will be added to or deducted from the base bid should alternate materials be accepted.

E. After first submittal, Engineer/Owner's Agent hourly rate will be charged to review further submittals.

2.2 GENERAL

A. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.

2.3 MATERIALS

A. Cementitious Repair Mortar:

1. Tnemec Series 217 MortarCrete
2. Cementitious repair mortar shall be a rapid-setting, non-shrinking resurfacing material capable of spray-transfer. Material shall have similar Coefficient of Linear Thermal Expansion (CLTE) properties as concrete.
3. Product information and performance criteria:

Recommended Dry Film Thickness per Coat	1/4"–4" horizontal/vertical
Application Time at 75F	Initial 60 min./Final 90 min.
ASTM C 1583 Bond strength at 1/4"	Concrete Failure
ASTM C 1583 Bond strength at 2"	Concrete Failure

Curing Requirements - ACI 308R Method Duration	 Wet Cure 1 hour
Compressive Strength - ASTM C579 (16 hr.) (28 days)	 8,670 psi 10,650 psi
Drying Shrinkage - ASTM C596 (28 day)	0% drying shrinkage
Coefficient of Linear Shrinkage - ASTM C 531 (28 day)	0.022%
Hydration (TDR Testing)	6 hours
Thermal Expansion- ASTM C531	7.46 x 10^{-6} in/in/F

B. Epoxy Cementitious Resurfacer:

1. Tnemec Series 218 MortarClad
2. Epoxy cementitious resurfacer shall be an epoxy-modified, aggregate reinforced material for surfacing, patching and filling voids and bugholes in concrete. The material shall be suitable for the application down to 1/16" inch thickness and be capable of spray-transfer.
3. Product information and performance criteria:

Recommended Dry Film Thickness per Coat	1/16"–1/2"
Application Working Time at 75F	60 min.
Maximum Recoat Window (with itself)	Unlimited
Minimum Substrate Temperature	40F
Curing Requirements - ACI 308R Method Duration	 Ambient Cure 15 hour
Compressive Strength - ASTM C579	7,100 psi
Flexural Strength - ASTM C580	1,290 psi
Splitting Tensile - ASTM C496	640 psi

C. Aggregate Reinforced Epoxy Mortar Basecoat:

1. Tnemec Series 434 Perma-Shield H2S
2. Epoxy Basecoat shall be a 100% solids, aggregate-reinforced, trowel-applied epoxy polymer protective barrier material specifically designed to protect concrete and steel surfaces in severe wastewater environments, including associated abrasive physical attack and chemical attack from sewer gases and organic acids generated by microbial sources.
3. Epoxy Basecoat shall be capable of achieving the specified thickness in a single coat application.
4. Product information and performance criteria:

Recommended Dry Film Thickness per Coat	125 mils
Application Time at 75F	30 min

Severe Wastewater Analysis - ASTM G210 Initial EIS Impedance (Log Z0.01 Hz Ω cm2) Final EIS Impedance (Log Z0.01 Hz Ω cm2)	 10.6 9.2
Not less than 86.7% retention in EIS Impedance	
ASTM D7234 Bond strength - Bare Concrete/434	Concrete Failure
ASTM D7234 Bond strength - 218/434	Concrete Failure
Chemical Resistance - ASTM C868 25% H2SO4, 100 days, 100°F	 No effect
Compressive Strength - ATSM D695	12,331 psi
Flexural Strength - ASTM C580	3,200 psi
Modulus of Elasticity	1.1×10^6 psi
Impact - ASTM D2794	160 in - lbs.
Coefficient of Linear Shrinkage - ASTM C531	-0.013%
Tensile Strength ASTM C307	2,030 psi
Thermal Expansion- ASTM C531	6.3×10^{-5} in/in/°F
Water Absorption ASTM C413	0.035%
Water Vapor Transmission ASTM E96 Procedure D	0.27 perms

D. Epoxy Topcoat and Epoxy Metal Coating:

1. Tnemec Series 435 Perma-Glaze
2. Product information and performance criteria:

Recommended Dry Film Thickness per Coat	15 - 20 mils Topcoat 30 – 40 mils Metal Coating
Color	Gray
Severe Wastewater Analysis - ASTM G210 Initial EIS Impedance (Log Z0.01 Hz Ω cm2) Final EIS Impedance (Log Z0.01 Hz Ω cm2)	 10.99 8.5
Not less than 86.5% retention in EIS Impedance	
ASTM D7234 Bond strength - Bare Concrete/434/435	Concrete Failure
Chemical Resistance - ASTM C868 25% H2SO4, 100 days, 100°F	 No effect
Compressive Strength - ATSM D695	9,427 psi
Elongation ASTM D2370	14.1%
Flexural Strength - ASTM D790	3,289 psi
Flexural Modulus of Elasticity – ASTM D790	15,790 psi
Tensile Strength ASTM D2370	2,053 psi
Tensile Modulus of Elasticity – ASTM D2370	1,180 psi
Water Absorption ASTM C413	No absorption after three trials
Water Vapor Transmission ASTM D1653 Method B, Condition C	0.49 perms

E. Applicator shall provide all accessory components such as polysulfide sealants, and curing compounds, as recommended by the manufacturer for maximum protective lining adhesion to substrate, and long-term service performance.

PART 3 - EXECUTION

3.1 GENERAL

A. Applicator shall provide, erect, and maintain all required hoists, scaffolding, staging and planking, and perform all access related hoisting work required to complete the Work of this Section as specified.

B. Applicator shall cover or otherwise protect finish work or other surfaces not being coated within the scope of this Section. Applicator shall erect and maintain protective tarps, enclosures and/or masking to contain debris, including dust or other airborne particles from surface preparation or application activities. This may include the use of dust or debris collection apparatus as required at no additional cost to Owner.

3.2 EXAMINATION

A. Site Verification of Conditions

1. Applicator shall examine the areas and conditions under which the protective coating Work is to be performed in accordance with NACE SP0892 and SSPC-SP13/NACE No. 6, and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work.
2. All concrete should be cured using the procedures described in ACI 308, allowing a minimum of 28 days at 75F.
3. The Applicator shall confirm the presence of a vapor barrier or positive side waterproofing on the exterior of the concrete structure.
4. Commencement of the Work of this Section shall indicate that the substrate and other conditions of installation are acceptable to the Contractor and his Applicator, and will produce a finished product meeting the requirements of the Specifications. All defects resulting from accepted conditions shall be corrected by Applicator at his own expense.

B. Stopping Active Leaks: After surface cleaning, any visible leaks or other water ingress shall be reported to the Engineer. Any water infiltration through minor leaks must be stopped using a polyurethane grout manufactured by Avanti International, Webster, TX (281-486-5600), or approved equal, or other approved method in accordance with ACI 224.1 Causes, Evaluation, and Repair of Cracks in Concrete Structures. Surface and grouting material may require additional surface preparation prior to application of protective coating.

3.3 SURFACE PREPARATION

A. Concrete surfaces to receive protective coating shall be cast with a Smooth Form Finish in accordance with ACI 301. Surfaces shall not be rubbed, sacked, troweled or otherwise finished in any manner that will obscure or cover the parent concrete surface with materials other than materials as specified in this Section.

B. All surfaces must be clean, dry and free of oil, grease and other contaminants, prior to preparation in accordance with NACE No. 6/SSPC-SP13. Concrete surfaces must be sound and capable of supporting the corrosion protection lining system.

C. Prepare concrete surfaces in accordance with NACE No. 6/SSPC-SP13 Joint Surface Preparation Standards and ICRI Technical Guidelines. Abrasive blast, shot-blast, water jet or mechanically abrade concrete surfaces to remove laitance, curing compounds, hardeners, sealers, existing coatings, and other contaminants and to provide the recommended ICRI-CSP Profile.

D. Level or grind concrete substrates to produce a uniform and smooth surface, including removal of sharp edges, ridges, form fins, and other concrete protrusions.

E. Steel – Structural and Pipe: Remove visible contaminants per SSPC-SP1. Prepare the steel surfaces in accordance with SSPC-SP5/NACE No.1 White Metal Blast Cleaning with a 3.0 mil minimum angular anchor profile.

F. Ductile or Cast Iron – Pipe, Pumps & Valves: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.

G. Non- Ferrous Metal Pipe & Misc. Fabrications: SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals to achieve a uniform anchor profile of 1.0 – 2.0 mils

3.4 APPLICATION

A. Protective coating systems shall be installed when ambient air and surface temperature is above 50°F. The substrate temperature shall be at least 5°F above the dew point. Condition the material between 70-80°F for 48 hours prior to use. Application when temperatures outside of this range will require written instruction from the Manufacturer and approval of the Engineer.

B. Application in direct sunlight and/or with rising surface temperatures is not allowed, as this may result in blistering of the materials due to expansion of entrapped air or moisture in the concrete. In such cases, it will be necessary to postpone the application until later in the day when the temperature of the substrate is falling. Concrete surfaces that have been in direct sunlight should be shaded for at least 24 hours prior to application. Consult the Manufacturer for application schedule guidelines specific to temperature conditions and possible sealer application recommendations to reduce outgassing.

C. Cementitious Repair Mortar: In areas of excessive deterioration use Series 217 MortarCrete cementitious repair mortar for structural repairs or surface repairs exceeding

a depth ½ - inch in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide.

1. Thickness – Minimum ¼" inch as required re-establishing original plane.
2. Cure – Water quench for one to two hours following installation as recommended by manufacturer.
3. Re-blast – Mechanically abrade the surface to remove the laitance layer and to uniformly profile the surface to produce minimum ICRI CSP 4 surface profile amplitude.

D. Epoxy Cementitious Resurfacer: Series 218 MortarClad epoxy cementitious resurfacer shall be used for filling voids, bugholes, static cracks and joints, for general concrete patching, and to provide a uniform, void free surface for Epoxy Lining application. Apply in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide

1. Thickness – Epoxy Cementitious Resurfacer shall be applied as a continuous parge coat at a minimum 1/16-inch thickness to the **entire** concrete surface.

E. Aggregate Reinforced Epoxy Mortar Basecoat: Series 434 Perma-Shield H2S epoxy lining protective coating shall be applied in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide.

1. Thickness – Epoxy lining shall be applied to a thickness of 125 mils (1/8- inch) dry film thickness to the entire surface.

F. Epoxy Topcoat: Series 435 Perma-Glaze epoxy glaze coat shall be applied over the epoxy lining system in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide.

1. Thickness – Epoxy glaze coat shall be applied to a thickness of 15-20 mils dry film thickness over the entire epoxy surface.

G. Epoxy Ferrous and Non-Ferrous Coating: Series 435 Perma-Glaze shall be applied over properly prepared substrates in accordance with Manufacturer's written instructions as outlined in the product data sheet and application guide.

1. Thickness – Epoxy Ferrous Metal coat shall be applied to a thickness of 30–40 mils dry film thickness applied in one or two coats over the entire substrate.

H. Terminations shall be installed in accordance with the Perma-Shield Lining Standard Details Guide:

1. In areas where the lining system is not required to be installed, a termination shall be built into the system.

I. Areas not to receive the lining system shall be masked or otherwise protected to prevent these surfaces from being coated.

3.5 FIELD QUALITY CONTROL, INSPECTION AND TESTING

A. Applicator shall perform the quality control procedures listed below in conjunction with the requirements of this Section.

B. Inspect materials upon receipt to ensure that the products are supplied by the approved Manufacturer.

C. Concrete Surface Profile: Inspect and record substrate profile (anchor pattern). Surfaces shall be profiled equal to the CSP 5 amplitude as recommended by the coating manufacturer in accordance with ICRI Guideline 310.2 and SSPC-SP13/NACE No. 6.

1. Compare the substrate profile once every 50 square feet with the Concrete Surface Profile (CSP) comparators in accordance with ICRI Guideline No. 310.2.
2. Perform replication of the concrete surface profile every 500 square feet using replica putty in accordance with ASTM D7682. Submit replications to the Engineer as part of the Jobsite Reports.

D. Concrete Surface Cleanliness: Prepared concrete surfaces shall be inspected for surface cleanliness after cleaning and drying, prior to resurfacing or coating application.

E. Concrete Moisture Testing: After surface preparation verify concrete dryness in accordance with ICRI Guideline 310.2 and SSPC-SP13/NACE No. 6 and one of the following test methods.

1. ASTM F1869 – Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
   a. Moisture vapor transmission not to exceed three pounds per 1,000 square feet in a 24-hour period.
2. ASTM F2170 – Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
   a. Relative humidity not to exceed 80 percent.
3. ASTM D4263— Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   a. No moisture present
4. Consult protective lining system manufacturer regarding questions and or recommendations about moisture problems or questions.

F. Surface pH Testing – Existing Concrete: After surface preparation test the pH of cement particles collected from the concrete substrate. The particles shall be measured using pH indicating paper or pH meter. The pH testing is to be performed once every 50 square feet for the first 500 square feet and then once every 500 square feet thereafter. Acceptable pH values shall be a minimum of 9.0 as measured using color indicating pH paper with readable color calibrations and a scale at whole numbers or pH meter.

G. Ferrous and Non-Ferrous Metal Surface Profile and Degree of Surface Cleanliness: Inspect and record substrate profile (anchor pattern) and degree of cleanliness. Surfaces shall meet the manufacturer’s recommended anchor profile and degree of blast cleaning.

1. Visually confirm the specified degree of surface cleanliness of the ferrous metal surface in accordance with SSPC-VIS 1.
2. The specified surface profile of the prepared substrate shall be verified in accordance with ASTM D4417 – Method C Replica Tape or NACE RP0287.

H. Measure and record ambient air temperature, relative humidity and dew point temperature once every two hours of each work shift.

I. Measure and record substrate temperature once every two hours using an infrared or other surface thermometer.

J. Film Thickness:

1. Wet-Film Thickness shall be taken every 100 square feet in accordance with ASTM D4414 or other agreed-upon method.
2. The Dry-Film Thickness can be determined using a surface area calculation for material consumption.

K. High-Voltage Holiday (Spark) Testing: Upon full cure, the installed lining system shall be checked by high voltage spark detection in accordance with NACE SP0188 and the Manufacturer's printed application guide to verify a pinhole-free surface. Areas which do not pass the spark detection test shall be corrected at no cost to the Owner.

1. Submit written reports of the test results and actions taken to correct non-conforming work.

L. Applicator is responsible for keeping the Engineer informed of progress so that Engineer may provide additional quality control at his discretion.

M. Inspection by the Engineer or others does not absolve the applicator from his responsibilities for quality control inspection and testing as specified herein or as required by the Manufacturer's instructions.

3.6 MANUFACTURER'S FIELD SERVICES

A. Manufacturer's technical representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.7 ACCEPTANCE CRITERIA

A. Surfaces shall be prepared, applied, and tested in accordance with the specification and referenced standards herein.

3.8 ADJUSTMENTS AND CLEANING

A. Protect the completed Work from traffic, physical abuse, immersion and chemical exposure until the complete system has thoroughly cured for 24 hours.

B. At the completion of the Work, Applicator shall remove materials and debris associated with the Work of this Section.

C. Clean surfaces not designated to receive protective coating. Restore all other work in a manner acceptable to Engineer.

D. Protect the completed Work from damage until Final Acceptance. Protective coating damaged in any manner shall be repaired or replaced at the discretion of Engineer, at no additional cost to Owner.

3.9 COATING SCHEDULE

A. Severe Wastewater Concrete Lining System

1. Surface Preparation: Abrasive Blast to remove laitance, form release agents, curing compounds, sealers, and other contaminants and to provide surface profile in accordance with SSPC-SP13/NACE6, ICRI CSP5.
2. Surfacer/Filler for all concrete surfaces: Tnemec, MortarClad Series 218 - parge coat of entire surface at a minimum thickness of 1/16” inch.
3. Basecoat: Tnemec, Perma-Shield H2S Series 434 at 125 mils DFT
4. Topcoat: Tnemec, Perma-Glaze Series 435 at 15 - 20 mils DFT

B. Severe Wastewater Ferrous Metal System – Steel

1. Surface Preparation: SSPC-SP5/NACE No.1 White Metal Blast Cleaning with a 3.0 mil minimum angular anchor profile.
2. Topcoat: Tnemec, Perma-Glaze Series 435 at 30 - 40 mils DFT applied in one or two coats.

C. Severe Wastewater Non-Ferrous Metal System – Aluminum, Stainless, etc.

1. Surface Preparation: SSPC-SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals with a 3.0 mil minimum angular anchor profile.
2. Topcoat: Tnemec, Perma-Glaze Series 435 at 30 - 40 mils DFT applied in one or two coats.

D. Severe Wastewater Ductile and Cast Iron

1. Surface Preparation: Prepare all surfaces as per NAPF 500-03 - Uniformly abrasive blast the entire exterior surface using abrasive to an NAPF 500-03-04 with a minimum angular anchor profile of 1.5 mils.
2. Topcoat: Tnemec, Perma-Glaze Series 435 at 30 - 40 mils DFT applied in one or two coats.

END OF SECTION

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period. Warranty Period: Six years from date of Substantial Completion.

1.6 QUALITY ASSURANCE

A. All extinguishers shall be checked and tagged by a certified tester in accordance with applicable standards and codes.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type: UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

SECTION 220010 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

Sections of other Divisions which relate to mechanical work apply to the work of this section and others. See various Sections on sitework, underfloor work, structural work, finish materials, etc.

B. Related Sections:

Refer to Seciton 220513 "Common Motor Requirements for Equipment" for basic electrical requirements for all mechanical equipment. Special and specific electrical requirements are specified within each respective equipment specification section.

1.2 SUMMARY

This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Divisions 22 and 23. It expands and supplements the requirements of Division 1.

This Division does not define, nor is it limited by, trade jurisdictions. All work described herein is a part of the General Contract and is required of the Contractor regardless.

1.3 DESCRIPTION OF PROJECT

The mechanical work described in these mechanical specifications is for a project located in Johnstown, Colorado. Design weather conditions are: summer 120° F (max), and winter 10°F (min). Altitude readings, unless otherwise noted, are approximately 4825 ft above sea level and adjustment to manufacturer's performance data shall be made accordingly.

1.4 CODES AND PERMITS, AUTHORITIES HAVING JURISDICTION

A. The mechanical work shall be performed in strict accordance with the applicable provisions of the various codes, ordinances and adoptions pertaining to the project location in effect on the date of invitation for bids. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the Contract Documents indicate materials or construction in excess of code requirements, the Contract Documents shall govern.

B. The Contractor shall hold and save the Owner and Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

C. Permits necessary for the prosecution of the work under this contract shall be secured and paid for by the contractor(s).

D. Reference Standards:

American Welding Society
International Mechanical Code/State Code
International Building Code/State Code
SMACNA Duct Design Standards
Local/State Plumbing Code
Locally enforced NFPA Codes
Local Fuel Utility Regulations
Local Power Utility Regulations
American Gas Association
ASME Codes for Pressure Vessels and Piping
ANSI B31.1 Piping

E. Final inspection by the Engineer will not be made nor Certificate of Substantial Completion issued until certificates of acceptability from the Authorities having jurisdiction are delivered.

1.5 DEFINITION OF PLANS AND SPECIFICATIONS:

The Mechanical Drawings show the general arrangement of piping, ductwork, equipment, etc., and shall be followed as closely as the actual building construction and the work of other trades will permit. The Architectural and Structural Drawings shall be considered as part of the work insofar as these Drawings furnish the Contractor with information relating to design and construction of the building. Architectural Drawings shall take precedence over Mechanical Drawings. Request clarification and participate in resolution in the event of conflict.

Because of the small scale of the Mechanical Drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate the structural and finish conditions affecting the Work and arrange the Work accordingly, providing such extensions, fittings, valves and accessories to meet the conditions as may be required.

Examine the actual construction site prior to bidding and obtain an understanding of the conditions under which the Work will be performed. No allowances will be made for failure to make such examination.

During construction, verify the dimensions governing the mechanical work at the building. No extra compensation shall be claimed nor allowed because of differences between actual dimensions and those indicated on the Drawings. Examine adjoining Work on which mechanical work is dependent for perfect efficiency and report any Work of other trades which must be corrected. No waiver of responsibility for defective work shall be claimed nor allowed due to failure to report unfavorable conditions affecting the Mechanical Work.

1.6 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to the specifications in the Contract Documents and individual supplier requirmeents for equipment-specific rough-in requirements.

1.7 MECHANICAL INSTALLATIONS

A. Coordinate mechanical equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

F. Coordinate the cutting and patching of building components to accommodate installation of mechanical equipment and materials.

G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

H. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

I. Coordinate the installation of mechanical materials and equipment above ceilings with suspension system, light fixtures, and other installations.

J. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.8 ACCESSIBILITY

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

C. Establish required clearance to all installation features involving operation and maintenance. Respect manufacturer's recommendations for access and clearance.

D. Access Doors - General:

All items of mechanical equipment which may require adjustment, maintenance, replacement or which control a system function shall be made readily accessible to personnel operating the building.

1. Provide access doors in all ductwork or plenums as required to maintain fire dampers, equipment, controls or other elements of the system. Doors shall conform to SMACNA standards unless otherwise detailed or specified.

2. Provide access doors in floors, walls, ceiling and partitions to valves, cleanouts, chases, dampers, etc., and to access doors in ductwork requiring the same. Access doors shall be all-steel construction equivalent to "Milcor" by Inland Ryerson in a style approved by the Owner's Representative. Doors shall be 24 inch x 24 inch, or as needed, with screwdriver latches.

1.9 CHANGE ORDERS (See General Conditions)

1.10 ALTERNATIVE CONSTRUCTION/SUBSTITUTION:

These documents outline a way in which the Owner may be delivered a functional and reliable facility. Contract Documents describe reasonable engineering practice for the Contractor to follow.

Coordination between trades may result in periodic needs to adjust the installation from that indicated, but in no case shall the intended function be compromised.

The Contractor may perceive some work methods which differ from those specified which could save time and effort. These may be presented to the Engineer with a breakdown of possible cost savings for review. Implement only with authorization.

Materials substitutions will generally be covered in a review process prior to bidding. After bidding, substitutions shall be proposed only on the basis of definitive cost accounting and implemented only with authorization.

1.11 CUTTING AND PATCHING

A. Layout the project ahead of time, providing sleeves and blockouts and have work specifically formed, poured and framed to accommodate mechanical installations. Cut and patch only as needed.

B. Record Drawings:

During the course of construction, maintain a set of drawings, specifications, change orders, shop drawings, addenda, etc., for reference and upon which all deviations from the original layout are recorded. These marked-up documents shall be turned over to the Engineer at the conclusion of the work so that the original tracings can be revised. If the Contractor fails to mark up the prints, he shall reimburse the Engineer for time required to do so. See Section 017839 "Project Record Drawings" for additional information.

C. BASIC ELECTRICAL REQUIREMENTS: Refer to Division 26 for requirements for cutting and patching electrical equipment, components, and materials.

D. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

E. Arrange for repairs required to restore other and any work damaged as a result of mechanical installations.

F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

G. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work;

2. Remove and replace defective Work;

3. Remove and replace Work not conforming to requirements of the Contract Documents;

4. Remove samples of installed Work as specified for testing:

5. Install equipment and materials in existing structures.

H. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer observation of concealed Work.

I. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping and other mechanical items made obsolete by the new Work.

J. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

K. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

1.12 SUBMITTALS:

Submittal of shop drawings, product data, and samples will be accepted only from the Contractor to the Engineer. Data submitted from subcontractors and material suppliers directly to the Engineer will not be processed. The Contractor shall document each transmittal and shall sign and stamp the submittal indicating that it has been reviewed and is in compliance with the criteria of the project, any exceptions being clearly noted. See Section 013300 "Contractor Submittals" for additional information.

A. Shop Drawings:

Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   a. Identification of products.
   b. Schedules.
   c. Compliance with specified standards.
   d. Notation of coordination requirements.
   e. Notation of dimensions established by field measurement.
   f. Relationship and attachment to adjoining construction clearly indicated.
   g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

3. Submit Shop Drawings in the following format:
   a. Two opaque (bond) copies of each submittal. Engineer will return one copy.

Equipment must fit into the available space with allowance for operation, maintenance, etc. The Contractor shall take full responsibility for space and utility requirements for equipment installed.

Factory-wired equipment shall include shop drawings of all internal wiring to be furnished with unit.

Review of the Engineer is for general conformance of the submitted equipment of the project specification; in no way does such approval relieve Contractor of his obligation to furnish equipment and materials that comply in detail to the specification, nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions which may affect his work. Refer to Section 013300 "Contractor Submittals" for additoinal requriemtns on shop drawing submittals.

1.13 GUARANTEE/WARRANTY:

The following guarantee is a part of this specification and shall be binding on the part of the Contractor and his assigns:

> "Contractor guarantees that this installation is in accordance with the terms of the Contract and is free from mechanical defects. He agrees to replace or repair, to the

satisfaction of the Owner's Representative, any part of this installation which may fail or be determined unacceptable within a period of one (1) year after substantial completion. See also the General Conditions of these specifications. Failed equipment in the repair or replacement shall be guaranteed for one full year from the date of recommission."

Compile and assemble the warranties required for piece of equipment and item into a separated set of vinyl covered, insert sheets, tabulated and indexed for each reference, included in the O&M Manual. See Section 017823 “Operations and Maintenance Data” for additional information.

Provide complete warranty information for each item to include product or equipment to include data of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

Mechanical systems and equipment shall not be considered for substantial completion and initiation of warranty until they have performed in service continuously without malfunction for at least ten (10) working days.

1.14 TESTS AND CERTIFICATIONS:

Make all tests required by code or specification in the presence of a representative of the Owner, recorded and certified by the Contractor and Representative. Involve local authorities where required. See Section 016600 “Equipment Testing and Plant Start Up” for more information.

1.15 PERMITS, FEES, LICENSES:

Pay for all permits, fees and licenses required for the conduct of the specified work and be responsible for all criteria associated with the same. Comply with requirements for inspection, certifications, etc.

1.16 CEILING SPACE COORDINATION:

Carefully coordinate ceiling cavity space with all trades; however, installation of mechanical equipment within the ceiling cavity space allocation, in the event of conflict, shall be in the following order: plumbing waste lines; supply, return and exhaust ductwork; domestic hot and cold water; control conduit.

PART 2 - GENERAL MECHANICAL MATERIALS AND METHODS

2.1 QUALITY OF MATERIALS AND EQUIPMENT

A. All equipment and materials shall be new, and shall be the standard products of manufacturers regularly engaged in the production of piping, plumbing, heating, ventilating and air

conditioning equipment, and shall be the manufacturer's latest design. Specific equipment shown in schedules on drawings and specified herein is to be the basis for the Contractor's bid. Provisions for substitute equipment are outlined in the General Conditions.

B. Furnish and install all major items of equipment specified in the equipment schedules on the drawings complete with all accessories normally supplied with catalog items listed, and all other accessories necessary for a complete and satisfactory installation.

2.2 PROTECTION OF MATERIALS AND EQUIPMENT

A. Close pipe and duct openings with caps or plugs to prevent lodgement of dirt or trash during the course of installation. Cover equipment tightly and protect against dirt, water and chemical or mechanical injury. Plumbing fixtures intended for the final installation shall not be used by the construction forces. At the completion of the work, clean fixtures, equipment and materials and polish thoroughly and deliver in a factory dock condition for the Owner's acceptance. Make damage and defects developing before acceptance of the work good at Contractor's expense.

B. Do not make temporary use of project equipment during construction without the consent of the Owner. Such use often represents a substantial percentage of the life expectancy of the device or system. DO NOT USE SYSTEM FOR TEMPORARY HEAT!!

2.3 QUALIFICATIONS OF WORKMEN

A. All mechanics shall be capable journeymen, skilled in the work assigned to them. Apprentices may be used with appropriate direction.

B. Employ no unskilled persons in the work which he is given to do; execute all work in a skillful and workmanlike manner. All persons employed upon this work shall be competent, faithful, orderly and satisfactory to the Owner. Should the Owner's Representative deem anyone employed on the work incompetent or unfit for his duties, and so certify, Contractor shall dismiss him and he shall not be again employed upon the work without permission of the Owner's Representative.

C. All welders involved in welding of pressure piping systems shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. Written verification of successful test completion shall be submitted to Engineer prior to initiating work.

2.4 FOREMAN

Designate a general mechanical foreman to the Owner's Representative to be consistently available on site for consultation. Do not replace this individual without prior approval from the Owner's Representative.

2.5 USE OF COMMON VENDORS

Regardless of subcontract delegations, coordinate purchasing between trades so that equipment and materials of similar nature come from a single vendor, i.e., all package HVAC units shall be common source. Base mounted pumps, valves, etc., the same. Do not burden the Owner with multiple brands of similar equipment unless so directed.

2.6 ROOF/WALL/FLOOR PENETRATIONS - FLASHINGS

A. Sleeves:

1. Sleeves through the floor into dry rooms shall be flush with the floor, caulked and sealed.

2. Sleeves through the floor into wet rooms shall be 2 inch above the floor, caulked and sealed.

B. Pipe sleeves shall allow for movement of the pipe due to expansion and contraction, yet to include seismic restraint.

C. Refer to Section 220517 “Sleeves and Sleeve Seals for Plumbing Piping” for fire stopping requirements.

D. Flashings:

1. Flash all pipes and ducts penetrating the roof. Vent pipes terminating within 24 inch of the roof shall have a seamless flashing as required in Section 075323 “EPDM Roofing” clamped to the pipe, and with a flashing shield extended horizontally not less than 12 inch all around. For single ply membrane roof, follow manufacturer's directions, provide required flashing components.

2. Other piping penetrating the roof shall be flashed and counterflashed. See Drawings or Engineer for additional detail.

3. Make all ductwork penetrating the roof watertight with flashings, counterflashing and sealant. Provide curbs for all such openings.

2.7 EXCAVATING AND BACKFILLING (GENERAL)

A. Provide all excavation, trenching and backfilling for Divisions 22, 23, and 26 underground piping work. Excavation and backfilling shall comply with applicable paragraphs of Division 31. Tamp bottoms of trenches hard and, for soil and waste piping, grade to secure uniform fall of ¼ inch per foot, or as noted. Excavate bell holes for hub and spigot pipes so that pipe rests on solid ground for its entire length. Lay sewer and water pipe in separate trenches, except where otherwise noted, as detailed.

B. After work has been tested, inspected and approved by the Owner's Representative and/or State/Local Inspector, and prior to backfilling, clean the excavation of all rubbish, and clean backfill materials free of trash. Backfill shall be placed in horizontal layers not exceeding 12 inch in thickness, properly moistened. Mechanically compact each layer with suitable

equipment to a dry density of not less than 95 percent as determined by the Modified AASHO Test T-18O. See Division 31 for additional requirements.

1. Provide adequate shoring to safeguard workers from cave-ins for all excavations.

2. In areas where General Contractor has finish grade work to do, Mechanical Contractor shall backfill and compact to 8 inch below finish grade. Where no finish surface work is to be done, Mechanical Contractor shall backfill and compact to and match adjacent undisturbed surface with allowance for settling, etc.

3. Protect from damage all existing underground utilities indicated on the Contract Drawings (or field located for the Contractor by the Owner prior to excavation operations). Any damage to identified existing utilities shall be repaired by the Contractor.

2.8 HANGERS AND SUPPORTS (GENERAL)

A. Provide hangers and/or supports for all equipment, piping and ductwork. Primary information is contained in Contract Documents.

B. Provide hangers and supports to correlate with seismic restraint and vibration isolation.

2.9 MANUFACTURER'S DIRECTIONS:

Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the plans and specifications, report such conflicts to the Engineer, who shall direct adjustments as he deems necessary and desirable.

2.10 LUBRICATION:

Lubricate equipment at startup. Then, provide all lubricants for the operation of all equipment until acceptance by the Owner. The Contractor is held responsible for all damage to bearings while the equipment is being operated by him.

2.11 ELECTRICAL WIRING AND CONTROL:

A. Motor starters, related motor starter equipment and power wiring indicated on the electrical drawings and control diagrams shall be furnished and installed under Division 26. Items of electrical control equipment specifically mentioned to be furnished by Divisions 22 and 23 either in these specifications or on the electrical or mechanical drawings, shall be furnished and mounted by this Contractor and shall be connected under and as required by the respected Divisions and Specifications.

B. Refer to the control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the contractor.

C. Divisions 22, 23, and 41 must be fully coordinated with Division 26 to insure that all required components of the work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of coordination.

D. Where the detailed electrical work is not shown on the electrical drawings, the Mechanical Contractor shall furnish, install and wire or have prewired all specified and necessary controls for package equipment and other equipment specified for this project. The objective of this paragraph is to make sure a complete operating system is obtained at no additional cost to the Owner for field wiring required related to the equipment.

2.12 FLUSHING AND DRAINING OF SYSTEMS/CLEANING OF PIPING AND DUCTS:

Fill, clean and flush and sterilize where appropriate, all water piping systems with water and drain these systems before they are placed in operation. Blow out all other piping systems with compressed air or nitrogen to remove foreign materials that may have been left or deposited in the piping system during its erection. Duct systems shall have all debris removed and fans shall be run to blow out all dust and foreign matter before grilles or outlets are installed and connected.

2.13 JOBSITE CLEANUP

A. Keep site clean during progress of work.

B. At the conclusion of work, clean all installation thoroughly.

1. Leave equipment in a factory dock condition. Correct any damage and touch up or repaint if necessary.

2. Remove all debris from site.

END OF SECTION 220010

SECTION 220050 – GENERAL PIPES AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General Conditions and Division-1 Specification sections, apply to work of this section.

1.2 SUMMARY:

A. This section is generic in that it describes material and installation required by several other sections of this specification.

B. Types of pipes and pipe fittings specified in this section include the following:

1. Steel Piping
2. Plastic Piping
3. Grooved Joint Piping
4. Miscellaneous Piping Materials/Products.

C. Pipes and pipe fittings furnished as part of factory - fabricated equipment, are specified as part of equipment assembly in other Division - 22 sections.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications:

1. Firm with at least three years history of successful experience on projects of similar nature.
2. Licensed as a firm in the contractor state of origin and in the State of Colorado.
3. Have a publicly registered bonding capacity of sufficient amount to cover this work and all other work in progress by the contractor.
4. All workmen employed on the project shall carry state licenses as journeyman or apprentice pipe fitters with additional certification for welders.

C. Welding Certification:

1. Each welder shall have passed a qualification test, which shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications", ASME Section VIII, and ANSI 313.
2. The test report shall certify that the welder is qualified to weld the material to be used at the job site.
3. The contractor shall submit three copies of each welder's qualification test report to the Project Manager for approval prior to commencing the work. No welder shall be used on the project until so certified.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.

B. Welding Certifications: Submit reports as required for piping work.

C. Brazing Certifications: Submit reports as required for piping work.

D. Maintenance Data: Submit maintenance data and parts lists for each type of mechanical fitting. Include this data, product data, and certifications in maintenance manual; in accordance with requirements of Division 1.

1.5 REFERENCES:

A. Codes and Standards:

1. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.
2. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Except for concrete, corrugated metal, hub-and-spigot, clay, and similar units of pipe, provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.

B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with

governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

2.2 STEEL PIPES AND PIPE FITTINGS:

A. Galvanized Steel Pipe: ASTM A 53.

B. Galvanized Seamless Steel Pipe: ASTM A 53.

C. Electric-Resistance-Welded Steel Pipe: ASTM A 135.

D. Electric-Fusion-Welded Steel Pipe: ASTM A 671, A 672, or A 691.

E. Cast-Iron Flanged Fittings: ANSI B16.1, including bolting.

F. Cast-Iron Threaded Fittings: ANSI B16.4.

G. Malleable-Iron Threaded Fittings: ANSI B16.3; galvanized or as indicated.

H. Unions: ANSI B16.39; 300 lb. ground joint malleable iron, hexagonal, selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.

I. Dielectric Unions: 175 psig WSP at 250ºF. Equal to Walter Vallet Company V-line insulating coupling.

J. Threaded Pipe Plugs: ANSI B16.14.

K. Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.

1. Material Group: Group 1.1.
2. End Connections: Buttwelding or slip on flanges.
3. Facings: Raised-face or flat faced.
4. Steel Pipe Flanges For Waterworks Service: AWWA C207.

L. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe.

M. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.

N. Pipe Nipples: Fabricated from same pipe as used for connected pipe.

2.3 PLASTIC PIPE AND PIPE FITTINGS:

A. Polyvinyl Chloride Pipe (PVC): ASTM D 1785. Schedule 80.

B. PVC Fittings:

1. Schedule 80 Socket: ASTM D 2467.

2. Schedule 80 Threaded: ASTM D 2464.

C. Polypropylene Pipe: Piping and fittings shall be manufactured to Schedule 80 iron pipe dimension, from virgin unpigmented polypropylene pipe grade material, without the addition of normal antioxidants or slip agents. The pipe shall be furnished in 10 foot lengths, cylindrical and straight, and sterile capped at time of manufacture. Pipe and fittings shall meet ASTM D2146, but without additives, and be manufactured to meet dimensional tolerances of ASTM D1785.

Fittings to have electric resistance coils.

2.4 GROOVED PIPING PRODUCTS:

A. General: As Installer's option, mechanical grooved pipe couplings and fittings may be used for piping systems having operating conditions not exceeding 230ºF (110ºC), excluding steam piping and any other service not recommended by manufacturer, in lieu of welded, flanged, or threaded methods, and may also be used as unions, seismic joints, flexible connections, expansion joints, expansion compensators, or vibration reducers.

B. Coupling Housings Description: Grooved mechanical type, which engages grooved or shouldered pipe ends, encasing an elastomeric gasket which bridges pipe ends to create seal. Cast in two or more parts, secure together during assembly with nuts and bolts. Permit degree of contraction and expansion as specified in manufacturer's latest published literature. (Victaulic style 77) For rigid joints (Victaulic "Zero Flex" style 07).

1. Coupling Housings: Malleable iron conforming to ASTM A 47.
2. Coupling Housings: Ductile iron conforming to ASTM A 536.
3. Standard: Enamel coated, options hot dip galvanized.

C. Gaskets: Mechanical grooved coupling design, pressure responsive so that internal pressure serves to increase seal's tightness, constructed of elastomers having properties as designated by ASTM D 2000.

1. Water Services: EDPM Grade E, with green color code identification.
2. Other Services: As recommended by Manufacturer.

D. Bolts and Nuts: Stainless Steel.

1. Exposed Locations: Tamper resistant nuts.

E. Branch Stub-Ins: Upper housing with full locating collar for rigid positioning engaging machine-cut hole in pipe, encasing elastomeric gasket conforming to pipe outside diameter around hole, and lower housing with positioning lugs, secured together during assembly with nuts and bolts.

F. Fittings: Grooved or shouldered end design to accept grooved mechanical couplings.

1. Malleable Iron: ASTM A 47.
2. Ductile Iron: ASTM A 536.
3. Fabricated Steel: ASTM A 53, Type F for 3/4" to 1-1/2"; Type E or S, Grade B for 2" to 20".

4. Steel: ASTM A 234.

G. Flanges: Conform to Class 125 cast iron and Class 150 steel bolt hole alignment.

1. Malleable Iron: ASTM A 47.
2. Ductile Iron: ASTM A 536.

H. Grooves: Conform to the following:

1. Standard Steel: Square cut.
2. Lightweight Steel: Roll grooved.
3. Ductile Iron: Radius cut grooved, AWWA C606.

I. Manufacturer: Subject to compliance with requirements, provide grooved piping products of one of the following:

1. ITT Grinnell Corp.
2. Stockham Valves & Fittings, Inc.
3. Victaulic Co. of America.
4. Gustin-Bacon
5. Grippin.
6. Or equal.

2.5 PIPING SPECIALTIES:

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions: Malleable-iron, Class 150; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends unless noted otherwise.

C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

D. Dielectric Waterway Fittings: electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.

E. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends and bodies matching piping system materials. Screens shall be Type 304 stainless steel, NPT, with a 250 micron filter disc. Amiad model T SuperPlastic filter or equal.

1. Provide strainers with 125 psi working pressure rating for low pressure applications, and 250 psi pressure rating for high pressure application.

2.6 EXPANSION JOINTS:

A. Rubber Expansion Joints: Construct of duck and butyl rubber with full-faced integral flanges, internally reinforced with steel retaining rings. Provide steel retaining rings over entire surface of flanges, drilled to match flange bolt holes, and provide external control rods.

B. Expansion Joints for Grooved Piping: Provide expansion joints constructed of cut grooved short pipe nipples and couplings, designed by manufacturer to suit intended service. Select couplings and gasket materials to match balance of piping system.

2.7 FLEXIBLE CONNECTORS:

A. Kevlar reinforced EPDM rubber with 150# stainless steel flanges. Connector shall have a minimum pressure rating of 125 psi at 170ºF, unless noted otherwise on the drawings. Product shall be Metraflex® Single MightySphere™ or equal. Connector shall allow for a minimum movement as shown below:

Joint Size ID (in)	Compression	Elongation	Lateral	Angular (Degrees)
2	1/2	3/16	3/8	15
2-1/2	1/2	3/16	3/8	15
3	1/2	3/16	3/8	15
4	5/8	3/16	3/8	15
5	5/8	3/16	3/8	15
6	5/8	3/16	3/8	15
8	5/8	3/16	3/8	15
10	3/4	1/4	1/2	15
12	3/4	1/4	1/2	15

2.8 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.

Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements. Use no lead bearing solders in domestic water applications.

Tin-Antimony Solder: ASTM B 32, Grade 95TA.

Silver-Lead Solder: ASTM B 32, Grade 96TS.

C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.

D. Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.

E. Strainer: Strainer shall be NPT, Amiad model T Super Plastic Filter or equal. Mesh size shall be as indicated in the equipment schedules.

F. Gaskets For Flanged Joints: ANSI B16.21; full-faced for flat-faced flanges; ring type for raised face flanges, unless otherwise indicated.

G. Piping Connectors For Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

1. Acceptable Manufacturers: Subject to compliance with requirements, provide piping connectors of the following:
    a. Fernco, Inc.
    b. Mission.
    c. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently- leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible union, flanges, etc., for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance. Do not cold spring. Store filler weld materials in accordance with codes.

Comply with ANSI B31 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated. Provide high point vents, low point drains with valves and extension to drain for all piping.

C. All piping in press room, mechanical rooms, fan rooms, etc., shall be exposed. Do not conceal or imbed piping in walls, floors or other structures.

D. Make changes in direction or size with manufactured fittings. Anchor and support piping for free expansion and movement without damage to piping, equipment or to building.

E. Piping shall be arranged to maintain head room and keep passageways clear.

F. Provide unions at connections to equipment and elsewhere as required to facilitate maintenance.

G. Run full pipe size through shutoff valves, gas cocks, balancing valves, etc. Change pipe size within three pipe size diameters of final connection to equipment, coils, etc.

H. All piping shall be erected to insure proper draining. Air or gas piping shall pitch down in the direction of flow a minimum of 1" per 40 feet unless noted otherwise on the drawings. Domestic water and utility water shall slope down a minimum of 1" per 40 feet towards the drain (low point). Refrigerant suction line shall slope a minimum of 1" per 10 feet towards compressor. Soil, waste, vent, and roof drain lines shall slope in accordance with requirements of Uniform Plumbing Code.

I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

J. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal. All sleeves shall be Schedule 40 unless noted otherwise.

K. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained.

L. Use fittings for all changes in direction and all branch connections.

M. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated.

N. Install unions adjacent to each valve, and at the final connection to each piece of equipment and plumbing fixture having 2" and smaller connections, and elsewhere as indicated.

O. Install Flanges in piping 2-1/2" and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.

P. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air).

Q. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water). Insulating fittings are not required between bronze valves and steel pipe or between copper coil headers and steel pipe.

R. Electrical Equipment Spaces: Do not run piping in or through, electrical room, transformer vaults and other electrical or electronic equipment spaces and enclosures or above electrical gear unless authorized and directed. Install drip pan under piping that must be run through electrical spaces.

3.2 EXPANSION AND CONTRACTION

A. Make all necessary provisions for expansion and contraction of piping.

B. Use grooved joint couplings, expansion compensators, offsets or loops as required to prevent undue strain.

C. At piping connection to heat exchangers provide expansion (joint) as shown on drawings.

3.3 FLEXIBLE CONNECTORS:

A. At pumps, engines and at all rotating or vibrating pieces of equipment, provide and install flexible connectors to accommodate alignment and vibration.

B. At engines provide and install flexible connectors.

3.4 PROTECTIVE COATINGS

A. All underground steel pipes shall be wrapped with Scotchwrap No. 50 tape to give not less than two complete layers on the underground piping system, or piping shall have "X-tru Coat", factory applied plastic protective covering, or pipe shall be coated and wrapped with coal tar enamel and Kraft paper, all with coated and taped joints.

3.5 PIPING SYSTEM JOINTS

A. General: Provide joints of type indicated in each piping system.

B. Threaded: Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

C. Brazed: Braze copper tube-and-fitting joints where indicated, in accordance with ASME B31.

D. Soldered: Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

E. Welded:

1. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31.
2. Weld pipe joints in accordance with recognized industry practice and as follows:
3. Weld pipe joints only when ambient temperature is above 0°F (-18°C) where possible, with minimum pipe preheat to 50°F.
4. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
5. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
6. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
7. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
8. At Installer's option, install forged branch-connection fittings wherever branch pipe is indicated; or install regular "T" fitting.

9. At Installer's option, install forged branch-connection fittings wherever branch pipe of size smaller than main pipe is indicated; or install regular "T" fitting.

F. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

G. Hubless Cast-Iron Joints: Comply with coupling manufacturer's installation instructions.

H. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards:

1. Heat Joining of Thermoplastic Pipe: ASTM D 2657.
2. Making Solvent-Cemented Joints: ASTM D 2235, and ASTM F 402.

I. Grooved Pipe Joints: Comply with fitting manufacturer's instructions for making grooves in pipe ends. Remove burrs and ream pipe ends. Assemble joints in accordance with manufacturer's instructions.

3.6 CLEANING, FLUSHING, INSPECTING:

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ASME B31 and Section 330505, “Pipeline Testing”.

B. Disinfect water mains and water service piping in accordance with AWWA C601.

END OF SECTION 220050

SECTION 220513 – COMMON MOTOR REQUIREMENTS FOR EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes AC induction electric motors to be provided with associated driven equipment. Motor voltage, speed and enclosures are specified in the equipment specifications. Unless otherwise specified, motors shall be provided by the manufacturer of the driven equipment under the provisions of the individual equipment specification.

1.2 MOTOR RATING

A. Motor horsepower ratings as shown on the drawings and noted on the specifications are estimates only and it is the responsibility of the CONTRACTOR and/or VENDOR to furnish motors, electric circuits, power feeds and other equipment whose ratings meet the requirements for the submitted horsepower and amperage.

B. This section applies to electric motors rated 480 V and below.

1.3 CODE AND STANDARDS

A. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 220, 250, and 430, as applicable to installation, and construction of motor controllers.

B. AFBMA Compliance: Comply with applicable requirements of AFBMA 9 & 11, "Load Rating and Fatigue Life for Ball and Roller Bearings."

C. UL Compliance: Comply with applicable requirements of UL 674, “Electric Motors and Generators, for Use in Division 1 Hazardous (Classified) Locations” and UL 1004, “Electric Motors”.

D. IEEE Compliance: Comply with recommended practices contained in IEEE Standard 112, "Standard Test Procedures for Polyphase Induction Motors and Generators," and IEEE Standard 841, “Standard for Petroleum and Chemical Industry – Totally Enclosed Fan Cooled (TEFC) Squirrel Cage Induction Motors – Up to and Including 500 HP”.

E. NEMA Compliance: Comply with applicable requirements of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies", NEMA Standard ICS 6, “Enclosures for Industrial Controls and Systems, ”Pub No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)" and NEMA MG 1, “Motors and Generators”.

1.4 MAINTENANCE DATA

A. Submit maintenance data and parts list for each motor and auxiliary component; including troubleshooting maintenance guide. Also, provide product data and shop drawings in a maintenance manual, in accordance with requirements of the Contract Documents.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's data and installation instructions for each motor in accordance with the individual equipment specification and Section 013300. As a minimum, the following information shall be provided:

1. Manufacturer name, type and model number
2. Motor outline, dimensions and weight
3. Manufacturer’s general descriptive information relative to motor features
4. Type of bearing and method of lubrication
5. Rated size of motor and service factor
6. Temperature rise and insulation rating
7. Full-load rotative speed
8. Efficiency at full, ¾ and ½ load
9. Full load current
10. Locked-rotor current
11. Space heater wattage and voltage, if applicable
12. If a winding overtemperature device is required, provide a response curve for the temperature device, wiring diagram and specifications
13. If a moisture detection system is required, provide a typical wiring diagram and a moisture detection relay to be installed by the CONTRACTOR or VENDOR in the associated motor controller.

B. Shop Drawings: Submit shop drawings of electric motors showing accurately scaled equipment locations and spatial relationships to associated drive equipment.

C. Wiring Diagrams: Submit power and control wiring diagrams for electric motors showing connections to electrical power panels, feeders, and equipment.

D. Operations and Maintenance Data: Submit operation and maintenance information as required by Section 017823.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide electric motors and ancillary components that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation.

2.2 SERVICE CONDITIONS

A. Unless specified otherwise, motors shall be suitable for continuous operation at an elevation of

0 to 5200 feet above mean sea level.

B. Unless specified otherwise, motors located outdoors shall be suitable for continuous operation from -25 to 50°C; motors located indoors shall be suitable for continuous operation from 0 to 50°C.

C. All motors shall be able to operate under power supply variations in accordance with NEMA MG 1 – 14.30.

2.3 NAMEPLATES

A. Motor nameplates shall be engraved or stamped stainless steel. Information shall include those items as enumerated in NEMA Standard MG 1, as applicable. Nameplates shall be permanently fastened to the motor frame and shall be visibly positioned for inspection.

2.4 CONSTRUCTION

A. All motors provided under this specification shall have the following features of construction:

1. Frames shall be steel for motors smaller than ½ horsepower and cast iron for motors ½ horsepower and larger.
2. Cast metal shrouds and covers for non-sparking fan blades.
3. Non-hygroscopic motor leads.
4. NEMA Design-B as standard design. Other designs if required must be submitted and approved in writing by the ENGINEER.
5. Motor Service Factor of 1.15 for Sine-Wave and 1.0 for Inverter Duty.
6. Grounding terminal
7. Windings shall be copper
8. Rotor cages shall be die cast aluminum or fabricated copper
9. Shafts shall be made from carbon steel.

2.5 MOTORS LESS THAN ½ HORSEPOWER

A. General:

1. Unless specified otherwise, motors less than ½ horsepower shall be squirrel cage, single phase, capacitor start, induction run type.
2. Single phase motors shall have class B insulation as a minimum.
3. Motors for fans less than 1/8 horsepower may be split-phase or shaded pole type.
4. Winding shall be copper.

B. Rating:

1. Unless specified otherwise, motors less than ½ horsepower shall be rated for operation at 115 volts, single phase, 60 Hz, and shall be continuous-time rated in conformance with NEMA Standard MG 1 – 10.35.
2. Dual voltage (115/230) rated motors are acceptable if all leads are brought out to the conduit box.

3. Motors shall be non-overloading at all points of the equipment operation.

2.6 MOTORS ½ HORSEPOWER AND LARGER

A. General:

1. Unless specified otherwise, motors ½ horsepower and larger shall be 3 phase, squirrel cage, full voltage start induction type.
2. Unless otherwise specified, motors shall have a NEMA MG 1-1.16 design letter B or C torque characteristic as required by the driven equipment's starting torque requirement.
3. Winding shall be copper.
4. Motors shall be equipped with a set of thermal overload switches with dry contacts available at the motor terminal box:

B. Rating:

1. Unless specified otherwise, motors ½ horsepower and larger shall be rated for operation at 460 volts, 3 phase, 60 Hz, and shall be continuous-time rated in conformance with NEMA Standard MG 1 – 10.35.
2. Dual voltage (230/460) rated motors are acceptable if all leads are brought out to the conduit box.
3. Motors for variable frequency systems shall not be required to deliver more than 80% of the motor's service factor rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.

C. Enclosures and Insulation:

1. Motors shall be classified as Type 1 (Process) or Type 2 (Explosion proof) based upon the location of the motor and the associated area classification.
2. Temperature rise for all motors shall not exceed that permitted by Note II, Paragraph 12.42 of NEMA MG 1.
3. Motor Insulation shall be non-hygroscopic.
4. Type 1 motors (Process):

    a. Type 1 motors shall be premium energy-efficient motors, totally enclosed, fan cooled (TEFC)
    b. All motors shall have Class H insulation with Class B temperature rise.
    c. All internal surfaces shall be coated with an epoxy paint.
    d. Motors shall be rated for corrosive atmosphere duty.

5. Type 2 Motors (Explosion Proof):

    a. Explosion proof motors shall be UL listed in accordance with UL 674 for Class I, Group D hazardous atmospheres.
    b. The motor shall have Class H insulation.
    c. A UL-approved Type 316 stainless steel breather/drain device shall be provided in the motor drain hole.
    d. The motor shall be provided with a frame temperature thermostat which meets the

UL frame temperature limit code T2A (280°C). The thermostat shall contain an automatically reset, normally closed contact rated 2 amperes at 230 VAC.

2.7 MOTORS FOR VARIABLE FREQUENCY DRIVES

A. Motors intended for use with variable frequency drives shall be compatible with the characteristics of the intended variable frequency inverter.

B. Motors shall be Type 1 or Type 2 as specified in 2.6.C.

C. Motors shall be capable of withstanding a pulse voltage of at least 1750 volts with a rate of rise up to 750V per microsecond.

D. Motors shall be certified by the manufacturer as suitable for inverter duty and shall have as a minimum a 10:1 turndown ratio (6-60Hz).

E. Motors shall be capable of running above the rated RPM up to 70 Hz (116.67% of rated RPM) so long as the load current does not exceed the full load amps of the motor.

2.8 MOTOR EFFICIENCIES

A. Type 1 and Type 2 motors in accordance with NEMA MG 1 Table 12-11 and 12-12 and Type 2 in accordance with IEEE 841 Table 2 motor minimum nameplate efficiency for 900, 1200 and 1800 rpm motors, when operating on a sinusoidal power source shall conform to the following (in accordance with IEEE 112B testing procedures):

Motor Horsepower	Guaranteed Minimum Efficiency (%)		
	900 RPM	1200 RPM	1800 RPM
1	70.0%	78.5%	81.5%
1.5	72.0%	81.5%	82.5%
2	80.0%	81.5%	82.5%
3	81.5%	86.5%	84.0%
5	82.5%	86.5%	84.0%
7.5	82.5%	88.5%	88.5%
10	86.5%	88.5%	88.5%
15	86.5%	89.5%	89.5%
20	87.5%	90.2%	91.7%
25	87.5%	91.0%	91.7%
30	89.5%	91.0%	91.7%
40	89.5%	92.4%	92.4%
50	90.2%	92.4%	92.4%
60	90.2%	93.0%	93.0%
75	91.7%	93.0%	93.6%
100	91.7%	93.6%	94.1%

125	92.4%	93.6%	94.1%
150	92.4%	94.5%	94.5%
200	92.4%	94.5%	94.5%
250	93.6%	94.1%	94.1%

2.9 CONDUIT BOXES

A. Conduit boxes shall be sized based on the conduit number and conduit size indicated on the drawings. Provide over-sized boxes with the number of openings as required to accommodate the conduits required.

B. Conduit boxes shall be split construction with threaded hubs and shall conform to IEEE 841 for Type 1 and Type 2 motors. Motors shall be furnished with petroleum-resistant gaskets at the base of the conduit box and between the halves of the conduit box.

C. Conduit boxes shall be designed to rotate in order to permit installation in any of four positions 90 degrees apart.

2.10 BEARINGS

A. Bearings may be oil or grease lubricated ball or angle contact roller bearing rated for a minimum L-10 life of 100,000 hours in accordance with ABMA 9 or 100 at the ambient temperature specified. Motor designs employing cartridge type bearings will not be accepted. Bearings shall be fitted with lubricant fill and drain or relief fittings. Belt loads shall not exceed forces calculated from NEMA MG 1 Table 14-1.

2.11 LIFTING EYES

A. Motors weighing more than 50 pounds shall be fitted with at least one lifting eye and motors weighing over 150 pounds shall be fitted with two lifting eyes.

2.12 SPACE HEATERS

A. Motors that are located outdoors shall be equipped with Space Heaters to prevent condensation inside the motor enclosure after motor shutdown and maintain the temperature of the windings at not less than 5°C above outside ambient temperature.

B. Heaters shall be flexible wraparound type rated 120 volts, single phase, 60 Hz unless otherwise noted. The space heater rating in watts and volts shall be noted on the motor nameplate or on a second nameplate. Space heater leads H1 and H2 shall be brought to a separate terminal block or pigtails in the motor conduit box or separate conduit box with a threaded conduit opening.

PART 3 - EXECUTION

A. Install electric in accordance with equipment manufacturer's written instructions, and with

recognized industry practices. Comply with applicable requirements of NEC, UL, and NEMA standards, to insure that products fulfill requirements.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

C. Ensure that the motor is properly grounded from the incoming motor leads and that the frame is bonded to the grounding electrode system.

D. Verify breather/drain fittings have been installed as specified.

E. Prior to energizing, check circuitry for electrical continuity, and for short-circuits. Winding insulation resistance for motors shall not be less than 10-megohms measured with a 1000-VAC megohmeter at 1-minute at or corrected to 40°C.

F. Check rotation of each motor for proper direction.

G. Upon completion of installation of motor controller equipment and electrical circuitry, energize controller circuitry and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, Grade A, with plain ends and welded steel collar; zinc coated. Hot dip galvanize after fabrication.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends. Hot dip galvanize after fabrication.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Connecting Bolts and Nuts: 316 Stainless Steel of length required to secure pressure plates to sealing elements.

B. Acceptable Manufacturers:

1. Link Seal
2. Or equal.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves 1 inch longer than penetration through floors.

2. Use foam and polyurethane caulk to seal space between pipe and sleeve.

D. Install sleeves for pipes passing through interior partitions.

1. Size sleeve for pipe and link seal.
2. Cut sleeves to length for mounting flush with both surfaces.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
4. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

END OF SECTION 220517

SECTION 220523 – VALVES

PART 1 - GENERAL

1.1 SCOPE:

A. Furnish and install all valves complete and in accordance to the requirements of the Contract Documents.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve.

B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts list for each type of valve. Include this data, product data, shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service.

B. Valve Types: Provide valves of same type by same manufacturer.

C. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

D. Codes and Standards:

1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".

PART 2 - PRODUCT

2.1 ECCENTRIC PLUG VALVES

A. All plug valves shall be of the tight-closing, resilient faced plug type and shall be of bi-directional eccentric seating such that the opening movement of the closing member results in the closing member rising off the body seat contact.

B. Valve bodies shall be constructed of cast iron ASTM A-48 Class 40. Flanges shall be faced and drilled in accordance with ANSI B16.1

C. Plug valves shall be furnished with permanently lubricated, sleeve type metallic bearings. Grit excluder seals shall be provided in the upper and lower journals to isolate the bearings.

D. Plug valve shaft seals shall be the self-adjusting type, replaceable without removing the valve bonnet.

E. Manual gear actuators shall be totally enclosed worm and gear type permanently lubricated. Above ground valves 6" and larger shall be provided with gear actuators. Buried valves 4" and larger shall be provided with gear actuators.

F. Available Manufacturers: Subject to compliance with requirements, manufacturers offering eccentric plug valves which may be incorporated into the work are:

1. Dezurik
2. ValMatic
3. Pratt
4. Or equal.

G. Valve Actuators: Actuators shall be noted on the plans. Actuators shall be electric On-Off type with a corrosion resistant NEMA 4, 4X die cast aluminum housing and cover, powder polyurethane coated, stainless steel fasteners, 8,600 in-lbs torque capability (or as required depending on valve size, type, and stem length) self-locking EPI-Cyclical gear train; no brake required, standard manual override with handwheel; manual override can be operated with any lever, clutch or brake upon power outage, visual position indicator, and a 120 VAC power supply. The actuator shall come fully tested and ready for installation. Mounting kits shall be provided.

2.2 AIR/VACUUM RELEASE VALVES

A. Valves shall be manufactured and tested in accordance with AWWA Standard C512.

B. The valve body shall be threaded with NPT inlets and outlets. The body inlet connection shall be hexagonal for a wrench connection.

C. The valve shall have two additional NPT connections for the additions of gauges, testing, and draining.

D. The cover shall be bolted to the valve body and sealed with a flat gasket. Resilient seats shall be replaceable and provide drop tight shut off to the full valve pressure rating.

E. Floats shall be unconditionally guaranteed against failure including pressure surges. Mechanical linkage shall provide sufficient mechanical advantage so that the valve will open

under full operating pressure. Simple lever designs shall consist of a single pivot arm and a resilient orifice button.

F. The valve body and cover shall be constructed of ASTM A126 Class B cast iron for working pressures up to 300 psig.

G. The orifice, float and linkage mechanism shall be constructed of Type 316 stainless steel. Non-metallic floats or linkage mechanisms are not acceptable. The orifice button shall be Viton for simple lever valves and Buna-N for compound lever designs.

H. The exterior of the valve shall be coated with a universal alkyd primer.

I. Valves installed in low pressure applications (e.g. less than 5 PSI operating pressure) shall be factory tested to ensure proper operation and complete sealing at the low operating pressure. Where required, a soft seat shall be provided for the float to prevent leaking in low pressure installations. Refer to the valve schedule and pump schedules for specific low pressure installation locations.

J. Available manufacturers:
   1. ValMatic,
   2. Or Equal,

2.3 PROCESS AIR BUTTERFLY VALVES

A. Butterfly valves shall be Bray Series40/41 High Performance Butterfly Valves, or equal. (Refer to schedule in drawings)

B. Valves shall be one piece wafer or lug stainless steel body style. (Refer to schedule in drawings)

C. Stem shall be high-strength, one piece stem 17-4 PH stainless steel. Disc shall consist of 316 stainless steel.

2.4 PROCESS BUTTERFLY VALVES 22" TO 48"

A. Butterfly valves shall be Bray Series 32/33 or equal. Provide Bray Series 32 for all applications with maximum design pressures of 50 psi. All other applications require Bray Series 33 for pressures up to 150 psi. (Refer to schedule in drawings).

B. For flange-style butterfly valves, valves shall be Bray Series 36 or equal.

C. Valves shall have a wafer body or full flanged body style.

D. Tongue-and-groove seat design with primary hub seal and a molded O-ring suitable for weld-neck and slip on flanges.

E. Seat shall be totally encapsulated with no flange gaskets required.

F. Spherically machined, hand polished disc edge and hub for minimum torque and maximum sealing capability.

G. Equipped with non-corrosive bushing and self-adjusting stem seals.

H. Bi-directional.

I. Valve body shall be Cast Iron ASTM A 126 Class B or Ductile Iron ASTM A536 Gr. 65-45-12.

J. Disc shall consist of 316 Stainless Steel ASTM A351.

K. Stem shall be high-strength, 304 Stainless Steel ASTM A276 Type 304.

L. All valves shall be factory tested to 110% of the specified pressure rating.

M. All valves shall be provided with either an electric actuator or a manual operator that includes a gear box and hand wheel, equivalent to Bray Controls Series 4 operator. The operator shall be a cast iron body with O-ring body seals in weatherproof to IP65. A self-locking worm and worm gear drive holds the valve in the desired position. The operator shall include a durable hand wheel to facilitate operating the valve. Contractor shall install the valve and operator such that it is easily accessible and not obstructed. Refer to the electrical specifications and valve schedule for electric actuator requirements.

2.5 PROCESS BUTTERFLY VALVES 2" TO 20"

A. Butterfly valves shall be Bray Series 30 or equal and shall have a wafer style body (refer to valve schedule in drawings) constructed of ASTM A536 Gr. 65-45-12 ductile iron.

B. Disc edge and hub on metal discs shall be spherically machined and hand polished for torque and maximum sealing capability. Disc shall be ASTM A351 316 stainless steel.

C. Valve stem shall be one-piece design with no possible leak paths in the disc-to-stem connection. Stem shall be ASTM A351 316 stainless steel.

D. Valve shall be rated for bi-directional service and shall be factory tested to 110% of the specified pressure rating. All valves shall be rated for a minimum service pressure of 150 psi.

E. Valve shall be equipped with non-corrosive bushing and self-adjusting stem seals.

F. All valves 6-inches and under not supplied with an electric actuator shall be furnished with a level or handle type actuator, equivalent to the Bray Series 1 Handle unless another type of actuator is specifically listed in the valve schedule.

G. All valves 8-inches and larger shall be provided with either an electric actuator or a manual operator that includes a gear box and hand wheel, equivalent to Bray Controls Series 4 operator. The operator shall be a cast iron body with O-ring body seals in weatherproof to IP65. A self-locking worm and worm gear drive holds the valve in the desired position. The operator shall include a durable hand wheel to facilitate operating the valve. Contractor shall install the valve and operator such that it is easily accessible and not obstructed. Refer to the electrical specifications and valve schedule for electric actuator requirements.

2.6 HOT WATER BUTTERFLY VALVES

A. Butterfly valves shall be Bray Series 20 or equal. (Refer to schedule in drawings)

B. Valves shall have a wafer or lug body style. (Refer to schedule in drawings)

C. Equipped with non-corrosive bushing and self-adjusting stem seals.

D. Bi-directional.

E. Valve body shall be Cast Iron ASTM A 126 Class B or Ductile Iron ASTM A536 Gr. 65-45-12.

F. Disc shall consist of 316 Stainless Steel ASTM A351.

G. Stem shall be high-strength, 304 Stainless Steel ASTM A276 Type 304.

H. All valves shall be factory tested to 110% of the specified pressure rating.

I. Seat shall be EPDM

2.7 BURIED BUTTERFLY VALVES

A. Valve shafts shall be of the through-type for sizes 3”-24”. 30” and larger shall be of the stub type design. Shafts shall be locked to the disc by O-Ring sealed taper pins retained with stainless steel nuts.

B. Valve exteriors for buried service shall be coated with an epoxy coating per specification 098000 (Protective Coatings).

C. Actuator shall be suitable for buried service and consist of a 2” nut with valve stem box to allow access to the actuator with a “Tee.”

D. Valves shall be Val-Matic Series 2000 or equal.

2.8 PLASTIC BALL VALVES (1/2” – 6”)

A. All valves shall be true-union design with 2-way blocking capability. PTFE seats shall have elastomeric backing cushions to provide smooth even stem torque and to compensate for wear.

B. Valve shall have a pressure rating of 150 psi at 70ºF.

C. Ball valves shall be provided with a vented ball for all chemical line service applications, including sodium hypochlorite chemical lines, and as indicated in the valve schedule.

D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering ball valves which may be incorporated in the work are:

1. Asahi America, Inc.
2. George Fischer Sloane
3. Dura Plastic Products, Inc.
4. Apollo
5. Hayward

6. Or equal.

2.9 STAINLESS STEEL BALL VALVES

A. Features:

1. 316 SS Ball Construction
2. SS Body construction
3. RPTFE seat
4. Threaded
5. Full Port
6. Two piece body design
7. Solid Ball Construction
8. SS Lever and Nut
9. Blow out proof stern design
10. Nylon lever grip
11. 150 psi rated

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering ball valves which may be incorporated in the work are:

1. Apollo Valves
2. Or equal

2.10 PLASTIC BALL CHECK VALVES

A. Ball Check valves shall be PVC, CPVC, PP or PVDF body with EPDM, FKM or PTFE seals. Valves shall be of solid thermoplastic construction, and be designed with an elastomeric uniseat/seal for tight shut-off under pressure. Sizes 1/2" – 2” shall be true union, and sizes 3” & 4” shall be single union.

B. Manufacturer must be ISO-9001 certified. Acceptable manufacturers:

1. Asahi-America, Inc.
2. Or equal.

C. Valves shall have a pressure rating of:

150 psi at 70° F sizes 1/2" – 2”

100 psi at 70° F sizes 3” & 4”

2.1 PLASTIC AIR RELEASE

A. Thermoplastics and elastomers to resist chemical erosion.

B. Body Material: CPVC

C. Plug (Poppet) Materials: EPDM Elostomer

D. Pressure Rating: 150 psi at 70° F

E. The valve body shall be threaded with NPT inlets and outlets

F. Available Manufacturers:
   1. Plast-o-matic series ARV thermoplastic air release valve
   2. Or equal

2.2 PLASTIC VACUUM RELIEF

A. Thermoplastics and elastomers to resist chemical erosion.

B. Body Material: CPVC

C. Spring Material: 304 Stainless Steel

D. Pressure Rating: 100 psi at 70° F

E. The valve body shall be threaded with NPT connections

F. Available Manufacturers:
   1. Plast-o-matic series VBS compact, self-closing vacuum breaker
   2. Or equal

2.11 STAINLESS STEEL CHECK VALVES (1/4” TO 2”)

A. Stainless steel check valves shall be threaded (NPT) valves and valve bodies shall consist of ASTM A315 CF8M 316 stainless steel.

B. Retainer, spring, and guides shall consist of 316 stainless steel.

C. Ball check shall be constructed of reinforced Teflon (RPTFE) or similar material suitable for corrosive and chemical exposure environments.

D. Acceptable make/model are Apollo model 62-100 stainless steel ball cone check valves or equal.

2.12 CHEMICAL LINE BACKPRESSURE AND PRESSURE RELIEF VALVES

A. Back pressure and pressure-relief valves for chemical line installations shall be an in-line diaphragm-style back pressure (anti-siphon) control valve with a built-in air release to help prevent air locking.

B. Valve body shall be PVC or CPVC as indicated in the valve schedule and shall have a field adjustable pressure range of 15 to 150 psig. For applications with design pressures less than 15 PSIG, factor shall provide a rubber elastomeric diaphragm.

C. Valve diaphragm shall be Teflon-laminated EPDM except for sodium hypochlorite applications where Viton shall be provided.

D. Ports for gauges (1/4" NPT) shall be provided where indicated in the drawings and/or the valve schedule. Contractor shall provide a liquid-filled gauge complying with the requirements of Division 26.

E. Valves shall be as manufactured by Top Valve model TV B and P (P2) or equal.

2.13 STAINLESS STEEL MUD VALVES

A. Mud valves shall be stainless steel with resilient seats as described herein. Valves shall be the non-rising stem type and be a heavy duty design. The body flange, yoke, guides and gate shall be cast stainless steel, type 316. After machining, all castings shall be passivated in accordance with ASTM A-380. Valves which include components welded from stainless steel are not acceptable. The resilient seat shall be of SBR rubber and mechanically retained. Resilient seats which are retained to the gate by adhesive or tension are not acceptable. Fasteners shall be stainless steel. The valve stem shall be one piece with an integral thrust collar and be cast or machined from type 316 stainless steel. Designs which pin a collar to the stem are not acceptable. The valve stem shall have Acme threads with the minimum diameters as shown below:

Valve Size	Minimum Stem Diameter
4"	1-1/4"
6"	1-1/4"
8"	1-1/2"
10"	1-1/2"
12"	1-1/2"
16"	1-1/2"
18"	1-3/4"
20"	1-3/4"

B. The valve shall be capable of withstanding a minimum input torque of 450 foot pounds, without damage to the valve. The valve shall not leak more than one quart per hour, when the valve is closed to a stem torque of 35 foot pounds. The manufacturer shall support leakage and torque testing with a report from an independent test laboratory.

C. The stem shall be coupled to the extension stem with a stainless steel machined coupling or a cast stainless 2" square operating nut and retained with a 5/16" stainless steel spring pin. No welded components of stainless are permitted for this connection or to the valve stem. Stems shall be retained with stainless fasteners assembled through holes drilled in the valve guide and yoke and retained with stainless hex nuts. Valve designs which retain the valve stem by threading stainless screws into tapped holes are not acceptable. The stem shall have a permanently bonded coating to prevent galling with other stainless components. The coating shall be capable of enduring a minimum of 15,000 open-close cycles without galling or excessive wear. The manufacturer shall support cycle testing with a report from an independent test laboratory.

D. The base flange shall be drilled per ANSI 125# standard and have a minimum thickness of ¾". The base flange shall be machined to provide a smooth seating surface. The extension stem

shall be type 316 stainless steel, of either schedule 40 pipe or solid round bar. The top nut, bottom coupling and connecting couplings shall be either cast or machined from type 316 stainless steel, but not include any welded components.

E. Stem Guides shall be constructed of cast stainless steel, type 316. Stem guides fabricated by welding stainless steel shall not be permitted. Stem guides shall include a bronze bushing with an inside diameter 1/16" larger than the outside diameter of the extension stem and shall be retained with two stainless steel screws. The stem guide shall be of the adjustable design for plumb alignment. The adjusting bolt and washer shall be type 316 stainless. Stem guides shall be spaced so that the unsupported length between extension stems shall not exceed 7 feet. Mudvalves shall be operated with extension stems, stem guides and either position indicators or indicating floorstands, as shown on the valve schedule or drawings. Mud valves and stem guides shall be as manufactured by Trumbull Industries, Youngstown, Ohio.

2.14 SUCTION LINE FOOTER VALVES

A. The footer valve shall be Valmatic Series #1900 foot valves flow globe style or equal, designed to provide positive seating and full flow area. The valve body shall be constructed of ASTM A126 Class B cast iron.

B. The valve seat and plug shall be ASTM A351 Grade CF8M stainless steel. The basket screen shall be type 304 stainless steel.

C. Footer valve shall be provided with flanges in accordance with ASNI B16.1 for Class 125 iron flanges.

D. Valves shall be hydrostatically tested at 1.5 times their rated cold working pressure. Exterior of the valve shall be coated with a universal alkyd primer per Section 098000.

2.15 GLOBE STYLE CHECK VALVES

A. Globe style valve bodies shall be Valmatic Series 1800 globe style check valves constructed of ASTM A536 Grade 65-45-12 ductile iron.

B. Globe and wafer seat and disc shall be ASTM B148 Alloy C95200 aluminum bronze. The globe compression spring shall be ASTM A313 type 316 stainless steel.

C. The valve shall incorporate a center guided, spring loaded disc and shall not be affected by the position of installation. Valve shall be capable of operating in the vertical or horizontal position with flow in either direction. Spring shall be designed to withstand 100,000 cycles without failure and provide a cracking pressure of 0.5 psi.

D. All components shall be field replaceable

E. Globe style valves shall have flat faced flanges in accordance with ASME B16.1 for Class 125 of Class 250 iron flanges.

2.16 SWING CHECK VALVES

A. The rubber flapper swing check valve shall have a heavily constructed cast iron body and cover in accordance with ASTM A126 Grade B. The body shall be long pattern design (not wafer) with integrally cast-on end flanges. The flapper shall be Buna-N, or other elastomer, having an O-ring seating edge and be internally reinforced with steel.

B. Flapper to be captured between the body and the body cover in a manner to permit the flapper to flex from closed to full open position. Flapper shall be easily removed without the need to remove the valve from line. Check Valves to have full pipe size flow area. Seating surface to be on a 45 degree requiring the flapper to travel only 35 degrees from closed to full open position for minimum headloss. Valve has non-slam closure characteristics.

C. Buna-N flapper which creates an elastic spring effect to assist the flapper to close against a slight head to prevent or minimize slamming.

D. Valve designed for 175 psi differential pressure for water, sewage, oil or gas (higher pressure available). The valve shall be suitable for buried service, in which case, stainless cover bolts must be furnished.

E. When necessary to prime or backflush a clogged pump, an external backflow device can be furnished—sizes 3” and larger.

F. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering swing check valves which may be incorporated in the work are:

1. ValMatic
2. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Except as otherwise indicated, comply with the following requirements:

Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections.

1. Pipe Size 2" and Smaller: One of the following, at Installer's option:

a. Threaded valves.
b. Flanged valves.

2. Pipe Size 2-1/2" and Larger:

a. Flanged valves.
b. Grooved joint valves.

D. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 VALVE INSTALLATION:

A. Locate all valves in locations which will allow easy operation and facilitates maintenance.

B. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

END OF SECTION 220523

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SECTION 220529 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Fastener systems.
4. Pipe positioning systems.
5. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Galvanized Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural galvanized steel shapes with MSS SP-58 galvanized steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from galvanized steel shapes.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

D. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

D. Provide concrete housekeeping bases for all floor mounted equipment furnished. Size bases to extend a minimum of 4" beyond equipment base in any direction; and 4" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Use shop paint for cleaning and touchup painting of field welds, bolted connections, and abraded areas on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified.

B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Use galvanized steel pipe hangers and supports and attachments for general service applications.

E. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

P. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 220553 – IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions and Division-1 Specification sections, apply to work of this section.

B. This section is Division-22 General Mechanical Materials and Methods section and is part of each Division-22 section making reference to identification devices specified herein.

1.2 DESCRIPTION OF WORK

A. Furnish mark and install identification devices for all exposed piping installed in this work.

B. Furnish and securely attach an engraved plastic nameplate to all new pieces of equipment (Owner or Contractor furnished).

C. Tag all valves installed in this work.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 IDENTIFICATION OF PIPING

A. Identification of all exposed pipe shall be accomplished by color-coding with bands and by lettering. Color bands shall be pressure-sensitive adhesive-backed vinyl cloth or plastic tape.

B. Each pipe identification shall consist of 2 color-coded bands, a printed label identifying the name of the pipe, and a flow arrow to indicate direction of flow in the pipe. All labels shall be preprinted on pressure-sensitive adhesive-backed vinyl cloth or plastic tape. Arrows shall be die-cut of the same type of material as the labels.

C. Preprinted identification devices shall be as manufactured by W.H. Brady Co., Seton Nameplate Corp., or equal.

2.2 VALVE TAGS

A. Valve Tags: Provide 1-1/2" x 3" size stainless steel or plastic valve tags with stamp-engraved 1/8" high letters.

B. Valve Tag Fasteners: Provide manufacturer's standard solid stainless steel chain (wire link or beaded type), or solid S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.3 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting.

3.2 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers on each piping system, and include arrows to show normal direction of flow:

Example of System Identification:

FLUID ABBREVIATION	FUNCTION IDENTIFICATION	ID COLOR
SD	SANITARY DRAINS & VENTS	BLUE
NPW	NON-POTABLE WATER	PURPLE

Coordinate with the Owner for all piping systems identification ID Coloring.

B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, crawl spaces, plenums) and exterior non-concealed locations.

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ ceilings or enter non-accessible enclosures.
4. Near major equipment items and other points of origination and termination.
5. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.

3.3 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures. List each tagged valve in valve schedule for each piping system. Valve tags shall include the following minimum information:

1. Plan Identification
2. Normal Position
3. Duty
4. Area served
5. Valve type.

B. Example of typical valve tag (where it is apparent what valve is serving):

B-14 Automatic 3-way mixing chlorine feed pump rate control
Position: 1/2 open
Function: Control flow rate

3.4 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Main control and operating valves, including safety devices and hazardous units such as non-potable water outlets. For non-potable water outlets use red engraved laminate with white lettering.
2. Pumps, compressors.
3. Press.
4. Air Handlers and Exhaust Fans, Furnaces, Condensing Units.
5. Polymer Feed Units.
6. Tanks and pressure vessels.
7. Open Control Equipment.

B. Lettering Size:

Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.

C. Text of Signs:

In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

D. A sample identification tag for equipment could be as follows:

Heating water pump Symbol P-1

Rating: 900 gpm, 120 ft. hd.
Maintenance: Lubricate with type C lubricant.

3.5 PANEL IDENTIFICATION

A. All panel devices on panel faces shall have engraved black face formica with white engraved lettering labels.

B. All internal panel components shall have engraved black face formica with white engraved lettering labels. Fasten label beneath each device.

C. All panel wiring and tubing shall be numerically or alphabetically coded.

3.6 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division.

B. Cleaning: Clean face of identification devices.

END OF SECTION

SECTION 220719 – PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services and related systems:

1. Non potable water piping.
2. Potable water piping.
3. Above ground interior hot water recirculation lines.
4. Above ground interior sludge piping.
5. Buried interior sludge piping.
6. Buried exterior sludge piping.
7. Other insulated piping indicated in the drawings

1.2 RELATED SECTIONS

A. Section 098000 – Protective Coatings

B. Section 220553 – Identification for Piping and Equipment

C. Section 221030 – Ductile Iron Piping

D. Section 238316 – Radiant Heating Hydronic Piping

1.3 DEFINITIONS

A. Exterior – Piping that is installed under canopies, outside a building, in the yard or within a trench or tunnel.

B. Interior – Piping that is installed inside a building.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
1. Insulation properties: Include K factor, thickness, density, operating temperature limits, tensile strength, compressive strength, moisture absorption, flame spread, and smoke developed in accordance with ASTM E84 and corrosivity to stainless steel piping in accordance with ASTM C 795.
2. Jacket properties: Include covering material, cover thickness, tensile strength, tear strength, permeability on accordance with ASTM E 96, flame spread, and smoke developed in accordance with ASTM E84, closure type or devices, and accessories.
3. Insulating blankets: Include materials, performance characteristics, listing of installation locations.
4. Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.5 SEQUENCING AND SCHEDULING

A. Pressure test piping and complete application of coating system before applying insulation.

B. When piping is to be heat traced, install and functionally test heat tracing before installation of insulation.

C. Before the installation of piping insulation verify acceptance of pressure piping tests, pipe coating application, and heat tracing tests by the Engineer.

PART 2 - PRODUCTS

2.1 PIPE INSULATION, GENERAL REQUIREMENTS

A. Insulation thicknesses: Provide insulation thickness in inches in accordance with the following table. Insulation thickness shown is nominal. Manufacturing tolerance of 15% variation is permissible.

Required Insulation Thicknesses (inches)					
Service Temperature Range as Designated in Insulation Schedule at End of this Section	Nominal Pipe Diameters				
	>1”	1.25” to 2”	2.5” to 4”	5” to 10”	10”<
Above 200 degrees Fahrenheit	2	2.5	3	3.5	3.5
100 to 200 degrees Fahrenheit	1.5	1.5	1.5	2	2.5
40 to 100 degrees Fahrenheit	0.5	1	1	1.5	2
Below 40 degrees Fahrenheit	1	1	1.5	2	2

2.2 PIPE INSULATION

A. Insulation Types: Provide in accordance with the insulation types listed in the table provided in Paragraph 3.8 of this section.

B. Insulation, Type 1:
   1. Insulation material: Closed cell elastomeric insulation
   2. Manufacturers: One of the following or equal
      a. Armstrong world industries, AP Armaflex
      b. Dyplast Products, ISO-C1
   3. Thermal conductivity at 75F shall not be more than 0.27 BTU in/hr ft^2 F.
   4. Joints: Seal with manufacturer's recommended contact adhesive to foam continuous barrier.

C. Insulation, Type 2.
   1. Insulation material: Styrofoam
   2. Manufacturers: One of the following or equal
      a. Polyguard products Dow Styrofoam PIB
      b. The Dow Chemical Company Styrofoam Brand Pipe Insulation
   3. Thermal conductivity at 75F shall not be more than 0.27 BTU in/hr ft^2 F.
   4. Joints: Seal with manufacturer's recommended contact adhesive to foam continuous barrier.

2.3 INSULATION JACKETS

A. Jacket, Type 1:
   1. Material: Ultraviolet resistant polyvinyl chloride jacketing, 20 mm minimum thickness.
   2. Color: White
   3. Overlap: 1-inch minimum at joints and fittings
   4. Joint seal: PVC solvent welded or adhesive as recommended by the manufacturer.
   5. Fittings: Factory made with full thickness insulation
   6. Manufacturers: One of the following or equal:
      a. Johns Manville, Zeston 2000 PVC
      b. ProtoCorp., LoSMOKE PVC
      c. Speedline Smoke Safe PVC Jacketing System
      d. Knaul Covering System, Proto PVC

B. Jacket, Type 2:
   1. Material: 0.024" thick embossed aluminum.
   2. Joint seal: ½" stainless steel bands
   3. Manufacturers: One of the following or equal:
      a. ITW Insulation systems Aluminum Roll Jacketing
      b. Profiles RH llc., Aluminum Roll Jacketing
      c. CJ metal Erectors ltd., Aluminum Roll Jacketing

2.4 REMOVABLE INSULATING BLANKETS

A. In piping systems specified to be insulated, use removable insulating blankets for valves, meters, strainers, filters, and other in-line piping appurtenances and equipment requiring periodic servicing.

B. Size limits: use removable insulating blankets for equipment and piping that are 3-inch in nominal size and larger. Insulate equipment and piping appurtenances less than 3-inch with molded sections of insulation or by field cutting insulation to conform to the shape of the component and to fit tightly around the component.

C. Manufacturers: One of the following, or equal
   1. Pittsburgh Corning, Temp-Mat
   2. Accessible Products, Thermazip 2000 Jacket
   3. Thermal Energy Products, Inc., Energy Wrap

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

   1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.2 PENETRATIONS

A. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.3 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.6 FINISHES

A. Do not field paint aluminum or PVC jackets.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers,

two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 PIPING INSULATION SCHEDULE, GENERAL

Service Designation	Location	Insulation Type	Jacket Type	Service Temperature (°F)
Non Potable Water	Exterior	Type1	Type 2	< 40
Hot Water	Interior	Type 1	Type 1	100 to 200
Hot Sludge	Interior	Type2	Type 2	100 to 200
Plant Drain	Exterior	Type 1	Type 2	<40

END OF SECTION 220719

SECTION 221116 - WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes under-building-slab and aboveground potable and non-potable water pipes, tubes, and fittings inside buildings.

1.2 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.3 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" included in the drawings for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with “NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:

1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
2. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:

1. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
2. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4 STAINLESS STEEL TUBING

A. Refer to Section 221060 – Stainless Steel Piping and Tubing

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

1. ASTM A 53/A 53M, Type E, Grade B, Standard Weight.

2. Include ends matching joining method.

B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.

C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Malleable-Iron Unions:

1. ASME B16.39, Class 150.
2. Hexagonal-stock body.
3. Ball-and-socket, metal-to-metal, bronze seating surface.
4. Threaded ends.

E. Flanges: ASME B16.1, Class 125, cast iron.

2.6 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 80.

1. CPVC Socket Fittings: ASTM F 439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

2.7 PEX TUBE AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

2.8 PVC PIPE AND FITTINGS

A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.

B. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.

C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.9 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.10 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:

1. Description:

a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket end.

D. Plastic-to-Metal Transition Unions:

1. Description:

a. CPVC or PVC four-part union.
b. Brass or stainless-steel threaded end.
c. Solvent-cement-joint plastic end.
d. Rubber O-ring.
e. Union nut.

2.11 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Watts; a division of Watts Water Technologies, Inc.
      b. Or Equal.

   2. Standard: ASSE 1079.
   3. Pressure Rating: 125 psig minimum at 180 deg F.
   4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

   1. Standard: ASSE 1079.
   2. Factory-fabricated, bolted, companion-flange assembly.
   3. Pressure Rating: 125 psig minimum at 180 deg F.
   4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

   1. Nonconducting materials for field assembly of companion flanges.
   2. Pressure Rating: 150 psig.
   3. Gasket: Neoprene or phenolic.
   4. Bolt Sleeves: Phenolic or polyethylene.
   5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

   1. Standard: IAPMO PS 66.
   2. Electroplated steel nipple complying with ASTM F 1545.
   3. Pressure Rating and Temperature: 300 psig at 225 deg F.
   4. End Connections: Male threaded or grooved.
   5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install seismic restraints on piping.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping to permit valve servicing.

N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

Q. Install PEX piping with loop at each change of direction of more than 90 degrees.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

T. Install thermostats in hot-water circulation piping.

U. Install thermometers on outlet piping from each water heater.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Piping: Join according to ASTM D 2855.

I. Joints for PEX Piping: Join according to ASTM F 1807.

J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
5. NPS 6: 48 inches with 3/4-inch rod.
6. NPS 8: 48 inches with 7/8-inch rod.

I. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

J. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.

K. Install hangers for vertical PEX piping every 48 inches.

L. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8: 48 inches with 7/8-inch rod.

M. Install supports for vertical PVC piping every 48 inches.

N. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Following testing of potable water lines, system shall be disinfected per AWWA standards prior to connecting to potable water source.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:

1. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:

1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
2. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be the following:

1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

G. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:

1. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

H. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
2. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.
3. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
4. Hard copper tube, ASTM B 88, Type L; copper push-on-joint fittings; and push-on joints.
5. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
7. PEX tube, NPS 1 and smaller; fittings for PEX tube; and crimped joints.
8. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
4. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
5. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
7. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed joints.
2. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
4. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
5. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
6. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:

1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
2. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.

END OF SECTION

SECTION 221119 - WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backflow Preventers.
2. Hose bibs.
3. Yard hydrants.
4. Non -Potable Water Filters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 and NSF 14.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers. Backflow preventers shall be tested by a certified Backflow Prevention Assembly Tester following installation. Products shall be as follows:

B. Reduced Pressure Zone Assemblies: A reduced pressure zone assembly shall be installed at each cross-connection to prevent back siphonage and backpressure of hazardous materials into the potable water supply. The assembly shall consist of a pressure differential relief valve located in a zone between two positive seating check valves. Backsiphonage protection shall include provision to admit air directly into the reduced pressure zone via a separate channel from the water discharge channel, or directly into the supply pipe via a separate vent. The assembly shall be constructed using lead free cast copper silicon materials. The lead free reduced pressure zone assembly shall comply with state codes and standards, where applicable, requiring reduced lead content. The assembly shall include two tightly closing shutoff valves before and after the assembly, test cocks and a protective strainer upstream of the No. 1 shutoff valve. The assembly shall have a maximum pressure loss of 12 psig through the middle third of the flow range. The assembly shall meet the requirements of ASSE std. 1013; AWWA Std. C-511-92 CSA B64.4; FCCCHR of USC Manual Section 10. The assembly shall be a Watts LF909 or equal.

2.4 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bib.
15. Include wall flange with each chrome- or nickel-plated hose bib.
16. Manufacturer: Watts Water Technologies Co., or equal.

2.5 YARD HYDRANTS

A. Yard Hydrants
1. Standard: ASME A112.21.3.M for exposed-outlet, self-draining wall hydrants.
2. 1” Female Inlet
3. Galvanized pipe casing
4. 1/8” Drain Hole
5. Removable Nozzle
6. Adjustable Link
7. Long life packing
8. Maximum working pressure 125 psi
9. Manufacturer: Watts Water Technologies Co., or equal

2.6 NON-POTABLE WATER FILTERS

A. Water filters shall be sizes ¾" to 3" and shall have a 50-micron filter unless noted otherwise. Filter shall be engineered plastic with no metal parts in contact with water. The filter elements shall be easily extracted from the filter housing for rinsing. Headloss shall be less than 5 psig at design flowrate. Filter shall have a temperature rating of 140F and a pressure rating of 150 psig. Connection type shall be as shown on drawings. Filters shall be Amiad or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install Y-pattern strainers where indicated.

F. Set yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.

G. Install water-hammer arresters in water piping according to PDI-WH 201.

H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

I. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding

for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 FIELD QUALITY CONTROL

A. Testing shall be according to authorities having jurisdiction, and according to the device's reference standard. Domestic water piping specialties will be considered defective if they do not pass tests and inspections. Any defective equipment shall be replaced at the Contractor's expense.

B. Test and inspection reports shall be prepared by a certified tester for each given specialty above. Test reports shall be delivered to the Engineer.

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 ABS PIPE AND FITTINGS

A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.

B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

D. Solvent Cement: ASTM D 2235.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

E. Solvent Cement: ASTM D 2564.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1) Fernco Inc.
2) Or Equal.

b. Standard: ASTM C 1173.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and stainless steel tension band and tightening mechanism on each end.
d. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Cascade Waterworks Mfg. Co.
2) Or Equal.

b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and stainless steel tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install seismic restraints on piping.

I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: Unless noted otherwise, 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install aboveground ABS piping according to ASTM D 2661.

M. Install aboveground PVC piping according to ASTM D 2665.

N. Install underground ABS and PVC piping according to ASTM D 2321.

O. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 “Escutcheons for Piping.”

3.3 JOINT CONSTRUCTION

A. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

B. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.5 VALVE INSTALLATION

A. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install stainless-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install stainless-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.

F. Install supports for vertical ABS and PVC piping every 48 inches.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

H. Install supports for ABS and PVC piping every 48 inches.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor.
6. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."

7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with protective coating system specified in section 098000 “Protective Coatings”.

END OF SECTION

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cleanouts.
   2. Trench drains.
   3. Floor drains.
   4. Miscellaneous sanitary drainage piping specialties.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Cast-Iron Cleanouts:
   1. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   2. Size: Same as connected drainage piping
   3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
   4. Closure: Countersunk, brass plug.
   5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2 TRENCH DRAINS

A. Pre-sloped Channel Drains
   1. Description: NDS Dura Slope Trench Drain Pro Series
      a. Nominal Size : Per plans.
      b. Minimum Channel depth: 4.75”
      c. Material: Molded, structural-foam polyethylene with UV inhibitor.
      d. Built-In Slope: 0.7 percent.
      e. Pre-Installed Locking System: Locks grate to integral frame.
      f. Rebar Supports: Per manufacturers recommendations.

g. Tongue-and-Groove Ends: Connect to allow for precise fit and straight channel runs.
h. Load Rating: Class D

2. Channel Grate

a. Description: UV protected high impact glass reinforced nylon.
b. Grate Openings: ¾" inch by 1-1/4" inches.
c. Load: Heavy Duty-Forklift

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Zurn Z-520 , Adjustable Heavy-Duty Drain, Or Equal
2. Standard: ASME A112.6.3.
3. Pattern: Area drain.
4. Body Material: Galvanized Cast Iron
5. Seepage Flange: Not required.
6. Anchor Flange: Not required.
7. Clamping Device: Not required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Not Required
11. Sediment Bucket: Yes
12. Top or Strainer Material: Cast Iron
13. Top of Body and Strainer Finish: Galvanized Cast Iron
14. Top Shape: Round.
15. Funnel: Not required.
16. Inlet Fitting: Not required.
17. Trap Material: Bronze.
18. Trap Pattern: Standard P-trap. Unless Noted Otherwise in Drawings.
19. Trap Features: Not required.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Vent Caps:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor and trench drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Install vent caps on each vent pipe passing through roof.

I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221426 – ROOF DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Plumbing Products Group; Specification Drainage Operation; **Z100** or comparable product by one of the following:

a. Josam Company.

b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.

d. Tyler Pipe, Wade Div.

e. Watts Water Technologies, Inc.

2. Standard: ASME A112.6.4, for general-purpose roof drains.

3. Body Material: **Cast iron**

4. Dimension of Body: Nominal **14-inch (357-mm)** diameter.

5. Combination Flashing Ring and Gravel Stop: **Required**.

6. Outlet: **Bottom**

7. Extension Collars: **Not required.**

8. Underdeck Clamp: **Required**.

9. Dome Material: **Cast iron**.

10. Perforated Gravel Guard: **Stainless steel**

11. Vandal-Proof Dome: **Not required.**

12. Water Dam: **Not required**

2.2 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M,12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

D. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.

2. Locate cleanouts at each change in direction of piping greater than 45 degrees.

3. Locate cleanouts at base of each vertical soil and waste stack.

E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

F. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

G. Install horizontal backwater valves in floor with cover flush with floor.

H. Install drain-outlet backwater valves in outlet of drains.

I. Install test tees in vertical conductors and near floor.

J. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

K. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

L. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

M. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

N. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. (30-kg/sq. m) lead sheets, 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of 4.0-lb/sq. ft. (20-kg/sq. m) lead sheets, 0.0625-inch (1.6-mm) thickness or thinner.

2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches (250 mm) and with skirt or flange extending at least 8 inches (200 mm) around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221426

SECTION 224500 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water Closets.
2. Flushometer valves.
3. Toilet Seats.
4. Lavatories.
5. Sinks.
6. Faucets.
7. Toilet Tissue Dispensers.
8. Paper Towel Dispensers.
9. Grab Bars.
10. Soap Dispensers.
11. Emergency Eye/face wash and Shower.
12. Hot Water Heaters.
13. Dishwasher.
14. Utility Sink.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.1 WATER CLOSETS

A. Type: Floor mounted, bottom outlet, top spud.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. American Standard America
      b. Or equal.
   2. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   3. Material: Vitreous china.
   4. Water Consumption: 1.6 gpf.
   5. Type: Siphon jet.
   6. Rim Contour: Elongated.
   7. Spud Size and Location: NPS 1-1/2", top.
   8. Color: White.
   9. Bowl-to-Drain Connecting Fitting: ASTM A 1045 or ASME A112.4.3.

B. Type: Wall mounted, top spud, accessible.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. American Standard America,
      b. Or equal.
   2. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   3. Material: Vitreous china.
   4. Type: Siphon jet.
   5. Style: Flushometer valve.
   6. Height: Standard.
   7. Rim Contour: Elongated.
   8. Water Consumption: 1.6 gpf.
   9. Spud Size and Location: NPS 1; top.
   10. Minimum Inlet: NPS 1.
   11. Minimum Outlet: NPS 1-1/4.

2.2 FLUSHOMETER VALVES

A. Type: Lever-handle, piston or diaphragm type.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Coyne & Delany Co.
      b. Sloan Valve Company.
      c. TOTO USA, Inc.
      d. Or equal.

2.3 TOILET SEATS

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. American Standard America.
   b. Or equal.
2. Standard: IAPMO/ANSI Z124.5
3. Material: Plastic.
4. Type: Commercial (Standard).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Non-corroding metal.
8. Seat Cover: Not required.
9. Color: White.

2.4 WALL MOUNTED LAVATORIES

A. Lavatory: Vitreous china, wall mounted, top spud.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. American Standard America.
      b. Or equal.
   2. Standard: ASME A112.19.2/CSA B45.1.
   3. Type: For wall hanging.
   4. Nominal Bowl Size: Oval, 15 by 10 inches.
   5. Faucet-Hole Punching: 4" on center.
   6. Faucet-Hole Location: Top.
   7. Color: White.
   8. Mounting Material: Chair carrier.

2.5 SINKS

A. Lab Sink: Epoxy Resin Drop-In Sink. Single bowl sink with waste fittings included. Nominal dimensions shall be 25-5/8" x 17-5/8", with bowl size of 24" wide by 16" by 8" deep.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Laboratory Fixtures
      b. Or equal.

2.6 FAUCETS

A. Lavatory Faucets: 4' centerset lavatory faucet shall be cast brass construction, gooseneck style, with all brass shank nuts and coupling nuts. Faucet shall feature water-conserving 1.5 gpm pressure compensating aerator and vandal-resistant handles with blue and red color indexes. Faucet shall also feature ¼ turn washerless ceramic disc valve cartridges.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. American Standard America.

b. Or equal.

B. Lab Faucets: Heavy duty cast brass sink faucet, with 4” centers, two handle, polished chrome plated finish, brass swing pout or 3/8” IPS brass pipe rigid/swivel gooseneck spout, metal hold-down package, color indexed metal handles with vandal resistant screws.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Delta.
b. Or equal.

2.7 TOILET TISSUE DISPENSERS

A. Surface-mounted multi-roll toilet tissue dispenser shall be type-304 stainless steel with all-welded construction, including dispensing mechanism, inner housing and cam; exposed surfaces shall have satin finish. Front of toilet tissue dispenser door shall be drawn, one-piece, seamless construction. Door shall be secured to cabinet with two rivets and equipped with a tumbler lock keyed like other Bobrick washroom accessories. Unit shall dispense two standard-core toilet tissue rolls up to 5-1/4” diameter. Extra roll shall automatically drop in place when bottom roll is depleted. Unit shall be equipped with two theft-resistant, heavy-duty, one-piece, molded ABS spindles.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Bobrick Washroom Equipment Co.
b. Or equal.

2.8 PAPER TOWEL DISPENSER

A. Surface-mounted paper towel dispenser shall be type-304 stainless steel with all-welded construction; exposed surfaces shall have satin finish. Door shall be secured to cabinet with a full-length stainless-steel piano-hinge and equipped with a tumbler lock keyed like other Bobrick washroom accessories. Paper towel tray shall have hemmed opening to dispense paper towels without tearing. Unit shall be capable of dispensing 400 C-fold or 525 multifold paper towels measuring 3-1/8" to 3-13/16" deep.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Bobrick Washroom Equipment Co.
b. Or equal.

2.9 GRAB BAR

A. Grab bar shall be type-304 stainless steel with satin-finish. Grab bar shall have 18-gauge wall thickness and 1-1/4” outside diameter. Clearance between the grab bar and wall shall be 1-1/2”. Concealed mounting flanges shall be 1/8” thick stainless steel plate, 2” x 3-1/8”, and equipped with two screw holes for attachment to wall. Flange covers shall be 22-gauge stainless steel, 3-1/4” diameter, and shall snap over mounting flanges to conceal mounting screws and/or WingIt fasteners. Ends of grab bar shall pass through concealed mounting flanges and be heliarc welded to form one structural unit. Grab bar shall comply with accessible design for structural strength.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Bobrick Washroom Equipment Co.
    b. Or equal.

2.10 SOAP DISPENSER

A. Surface-mounted liquid soap dispenser shall be fabricated of 20 gauge satin finish stainless steel. Dispenser shall have completely concealed mounting, vandal-resistant filler hole cover and sight gauge. Push-in corrosion-resistant liquid soap valve. Capacity: 40-oz. liquid soap. Requires less than 5 lbs. of force to dispense soap. Overall dimensions: 413⁄16"W x 83⁄16"H x 27⁄8"D
    1. Manufacturers: Subject to compliance with requirements, provide products by the following:
        a. Bradley Corp.
        b. Or equal.

2.11 EMERGENCY SHOWER/EYEWASH

A. Combination Drench Shower and Eye/Face wash unit shall be operated by a pull rod with a triangular handle. Shower shall comply with ANS Z358.1, shall be galvanized steel with a full, one-year warranty. Showerhead shall supply 25 gpm at 40 psig. Eyewash bowl shall be 10-3/4" diameter corrosion-resistant stainless steel. Spray head assembly shall have twin perforated-disc eye/face wash heads with protective spray head covers, operated by a large, highly visible push handle and a foot treadle. Shower valve shall be chrome-plated brass 1" NPT stay-open ball valve, operated by a stainless steel pull rod with a triangular handle.
    1. Manufacturers: Subject to compliance with requirements, provide products by the following:
        a. Bradley Corp.
        b. Or equal.

B. Faucet Mounted Eyewash: chrome plated brass spray head assembly with twin soft-flow eyewash heads and highly visible yellow plastic protective covers. Safe, steady water flow under varying water supply conditions from 30-90 psi shall be assured by integral flow control in the spray head assembly.
    1. Manufacturers: Subject to compliance with requirements, provide products by the following:
        a. Bradley Corp.
        b. Or equal.

2.12 HOT WATER HEATER

A. Water heater shall be light duty commercial with vertical dual-pass heat exchanger system, self-priming condensate tee, power vent, horizontal and vertical venting, intelligent gas control with spark to pilot ignition system, sediment reducing device, Vitraglas lining, 2" non-CFC foam insulation, pedestal base, factory-installed heat traps, two protective anode rods, T&P relief valve, low restrictive brass drain valve and NOx emissions of less than 40 ng/J.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Tankless, Inc.
    b. Or equal.

2.13 DISHWASHER

A. Dishwasher shall have digital microprocessor control with digital display, six selectable wash cycle settings, selectable temperature settings from 84F to 158F, selectable convection drying, final DI rinses for all cycles, 304 stainless steel interior and exterior construction, triple filtration system to protect plumbing and pump from broken glass and debris, separate wash and rinse pumps.
    1. Manufacturers: Subject to compliance with requirements, provide products by the following:
        a. SP Scientific
        b. Or equal.

2.14 UTILITY SINK

A. Utility sink with 2" wide Euro-style edging on front and sides. Sink bowl is heavy gauge type 304 SS with 13-1/2" water level, deep drawn, seamless and have all corners covered. Top – including backsplash and drainboards – is heavy gauge type 430 SS. Drainboards shall be "V" creased for positive drainage. 9-1/2" high backsplash with 1" upturn and tile edge. Legs to be 1-5/8" OD galvanized tubing with front-to-back cross bracing, and 1" high impact plastic adjustable bullet feet.
    1. Manufacturers: Subject to compliance with requirements, provide products by the following:
        a. Eagle Group.
        b. Or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine counters and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted fixtures.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between fixtures and counters and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible fixtures. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. After completing installation of fixtures, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fixtures with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

3.6 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if

permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523 "Valves."

B. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

C. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

E. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations.

F. Fill self-contained fixtures with flushing fluid.

3.7 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 224500

SECTION 230100 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

A. General Conditions and Division 01 apply to this Division.

1.2 SCOPE

A. Includes -

1. Furnish all labor, materials, and equipment necessary for the completion of the mechanical and plumbing scope of work.
2. Furnish and install all motors specified in this Division and be responsible for the proper operation of electrical powered equipment furnished by this Division.
3. Furnish exact location of electrical connections and information on motor controls to Division 26.
4. Mechanical Contractor shall obtain the services of independent Test and Balance Agency.
5. Placing the air conditioning, heating, ventilating, and exhaust systems into full operation and continuing their operation during each working day of testing and balancing.
6. Making changes in pulleys, belts, and dampers, or adding dampers, as required for the correct balance as recommended by Balancing Contractor at no additional cost to Owner.
7. Air balance, final adjustment and test run.
8. The satisfactory performance of the completed systems is a requirement of this specification.

B. Related Work Specified Elsewhere

1. Conduit, line voltage wiring, outlets, and disconnect switches specified in Division 26.
2. Magnetic starters and thermal protective devices (heaters) not a factory mounted integral part of packaged equipment are specified in Division 26.

1.3 SITE OBSERVATION

A. The Contractor shall examine the site and understand the conditions which may affect the performance of work of this Division before submitting proposals for this work.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS

A. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc; however, locations are to be regarded as shown diagrammatically only. Follow as closely as actual building construction and work of other trades will permit.

B. Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate existing structural and finished conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.
If changes in location of piping, equipment, ducts, etc. are required due to lack of coordination of work under this division, such changes shall be made without charge. Contractor shall review drawings with local and state agencies having jurisdiction and any changes required by them shall be brought to the attention of the Engineer prior to bidding or commencement of work. It is understood that while Drawings are to be followed as closely as circumstances permit, this Division will be held responsible for the installation of systems according to the true intent and meaning of the Contract Documents. Anything not clear or in conflict will be explained by making application to the Engineer in writing. Should conditions arise where certain changes would be advisable, secure Owner's and Engineer approval for these changes before proceeding with work.

1.5 COORDINATION OF WORK:

A. Coordinate work of various trades in installing interrelated work. Before installation of mechanical items, make proper provision to avoid interferences in a manner approved by Engineer. Changes required in work specified in Division 22 and 23 caused by neglect to secure approval shall be made at no cost to Owner.

B. Arrange piping, ductwork, and equipment to permit ready access to valves, unions, starters, motors, control components, and to clear openings of doors and access panels. Contractor shall provide all necessary access doors and/or panels to provide complete access to all mechanical equipment, dampers, or accessories. Doors for dampers, etc. shall be minimum 12" x 12" and doors for mechanical equipment shall be minimum 24" x 24".

C. Furnish and install inserts and supports required by Division 22 and 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions involved in sufficient time to be built into the construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne by Contractor.

D. Be responsible for required digging, cutting, and patching incident to work of this Division and make required repairs afterwards to satisfaction of Owner and Architect. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.

1. Patch and repair walls, floors and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
2. This Division shall bear expense of cutting, patching, repairing, and replacing of work of other Divisions because of its fault, error, tardiness, or because of damage done by it.
3. Provide the necessary cutting, patching, repairing, and replacing pavements, sidewalks, etc. to permit installation of work of this Division.

E. Adjust locations of piping, ductwork, equipment, etc, to accommodate work from interferences anticipated and encountered. Determine exact route and location of each pipe and cut prior to fabrication.

1. Make offsets, transitions, and changes in direction of piping, ductwork, and electrical raceways as required to maintain proper head room and pitch of sloping lines whether or not indicated on Drawings.

F. Slots and openings through floors, walls and roofs shall be provided by this Division.

G. This Contractor shall schedule his work, store his equipment and materials, and work in harmony with other Contractors so as to not delay or jeopardize the construction.

H. This Division shall coordinate with electrical contractor to insure that all required components of control work are included and fully understood. Any discrepancies shall be called to the attention of the Engineer before completion of bids. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.6 EQUIPMENT & MATERIALS:

A. Requests for substitution shall be received in writing a minimum of seven days prior to bidding. Prior acceptance shall be by Manufacturer's name only. Items not listed in this specification or subsequent addendums shall not be considered. No oral approvals will be acceptable. Manufacturers listed in this specification are acceptable only for items listed. All other items manufacturer wishes to bid must be prior approved. All equipment shall be subject to final review in accordance with "Project Submittals".

B. Product Approvals -

1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.

2. In the event other than specified equipment is used and will not fit job site conditions, this Division assumes responsibility for replacement with items named in Specification.

C. Use domestic made pipe, pipe fittings, and motors on Project.

D. Motor and equipment name plates as well as applicable UL labels shall be in place when Project is turned over to Owner.

E. Insure that items to be furnished fit spaces available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents. Do not scale off drawings.

F. All materials shall be of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended. Materials shall be new unless specifically excepted.

G. Equipment catalog or model numbers shown define the basic equipment types and quality standard only. Catalog numbers shall not be considered as all inclusive and shall be verified to include all devices, controls, operators, and appurtenances necessary for the satisfactory and complete operation of the equipment.

H. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.

1. Promptly notify Engineer in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain Engineer's written instructions before proceeding with work. Contractor shall bear all expenses arising from correcting deficiencies of work that does not comply with Manufacturer's directions or such written instructions.

I. Deliver equipment and material to site and tightly cover and protect against dirt, water, and chemical or mechanical injury but have readily accessible for inspection. Store items subject to moisture damage (such as controls) in a dry, heated space.

1.7 PROJECT SUBMITTALS:

A. Furnish complete catalog data for manufactured items of equipment to be used in the Work to for review within 15 days after award of Contract.

B. Submittal shall include, but not be limited to the following:

1. equipment scheduled
2. balancing contractor
3. insulation
4. grilles, and diffusers
5. automatic temperature controls
6. certificates of guarantee
7. valves
8. plumbing fixtures, accessories, and specialties
9. any item for which more than one manufacturer is mentioned

C. Submit a minimum of five copies of data in binders and index in same order and name as they appear in Specification. - Optional: Provide electronic submittals. Electronic submittals shall be in .pdf format, and shall be compiled into a single file, with bookmarks for each piece of equipment.

1. State sizes, capacities, brand names, motor HP, electrical requirements, accessories, materials, gauges, dimensions, and other pertinent information.
2. List on catalog covers page numbers of submitted items.
3. Underline or highlight applicable data.

D. If material or equipment is not as specified or submittal is not complete, it will be rejected.

E. Catalog data or shop drawings for equipment which are noted as approved shall not supersede Contract Documents.

F. Review comments shall not relieve this Division from responsibility for deviations from Contract Documents unless attention has been called to such deviations in writing at time of submission, nor shall they relieve this Division from responsibility for errors in items submitted.

G. Check work described by catalog data with Contract Documents for deviations and errors.

H. All items other than first named specified equipment shall show and state all exceptions and deviations taken and shall include design calculations and drawing layouts.

I. The Contractor shall review the submittals prior to submission to make sure that the submittals are complete in all details. No submittal will be reviewed which does not bear the contractor's notation that such checking has been made.

J. No partial submittals will be considered unless approved by the Engineer.

K. Manufacturers' names shall be mentioned as acceptable prior to bidding.

L. Contractor shall verify equipment dimensions to fit the spaces provided with sufficient clearance for servicing the equipment.

M. Contractor shall review equipment submittals for compliance with schedules, specifications, and drawing plans and details. Equipment submittal shall show the proper arrangements to suit installation and maintenance such as motor location, access doors, filter removal, piping connections, etc.

N. Equipment submittal sheets shall be clearly marked indicating equipment symbol and exact selection of proposed equipment. Submittals shall clearly indicate name of manufacturer of each item.

O. For unacceptable items, the right shall be reserved to require the first named specified items.

P. Where submittals are sent with any of the above listed information missing or are incomplete they will be returned to the contractor unchecked to be completed and resubmitted. No additional time or money shall be allowed for failure to provide complete submittals on the first review.

Q. If an item requiring submittal review is ordered, purchased, shipped, or installed prior to the submittal review the item shall be removed from the job site and replaced with an approved item at contractors expense.

1.8 CLEANING & FINISHING:

A. Contractor shall, at all times, keep the premises free from waste material and rubbish. Upon completion of this Section of the work, Contractor shall remove all surplus materials and rubbish; clean all spots resulting from the mechanical work from hardware, floors, glass, walls, etc.; do all required patching up and repair all work of other trades damaged by Contractor

under this Section of the work, and leave the premises in a clean orderly condition. Clean heating and cooling coils, internally and externally, and replace all air filters prior to final mechanical inspection. Remove rust, plaster, dirt, grease and oil before painting, insulating, or exposing to view the equipment, piping, ductwork, etc. in completed structure. Refinish any damaged surfaces and leave in proper working order at final completion.

1.9 EQUIPMENT SERVICING:

A. Prior to starting mechanical equipment, all motors, bearings and moving parts shall be properly oiled, greased and lubricated as required. Full and adequate maintenance service shall be given and upon completion all equipment shall be cleaned and checked and placed in perfect condition for the Owner.

B. Amount and type of lubricant shall be per manufacturer's specification.

1.10 SUPERVISION:

A. The Contractor shall supervise and direct the work with his best skill and attention. He will be solely responsible for the means, methods, techniques, sequences and procedures of construction. The Contractor will be responsible to see that the finished work complies accurately with the Contract Documents.

1.11 SAFETY REGULATIONS:

A. Contractor shall provide equipment, supervision, construction, procedures, and everything necessary to assure safety of life or property.

B. Refer also to General Condition and Special Conditions for protection clauses.

1.12 LEAK DAMAGE:

A. Contractor shall be responsible for damages to the work of other Contractors or to the building, or to its contents, people, etc., caused by leaks in any of the equipment or piping installed by him through equipment or material failures, leaking joints or disconnected pipes, fittings, or by overflows and shall make at his own expense all repairs to fixtures, building interior, contents, paint, rugs, furniture, ceiling tile, and equipment so damaged.

1.13 TOOLS AND STORAGE OF EQUIPMENT:

A. The Contractor shall furnish all necessary tools, staging and whatever may be necessary for the installation of this work and shall at all times protect this work and others, and the materials to be used therein from damage by the weather, accident and other causes, and shall repair and make good any damage thus occurring.

1.14 WORKMANSHIP:

A. Workmanship shall be the best quality of its kind for respective industries, trades, crafts and practices and shall be acceptable in every respect to the Owner and Engineer. Nothing contained herein shall relieve the Contractor from performing good work, perfect in all details of construction.

1.15 PAINTING BY CONTRACTOR:

A. Painting shall be by persons experienced in painting.

B. All exposed, insulated, and bare piping, equipment, metal stands and supports shall be painted as follows:

1. The prime coat on equipment shall be factory applied. The finish coats shall be applied under Section 09900 of these specifications.
2. All equipment which is to be furnished in finished painted condition by Contractor shall be left without mark, scratch or impairment to finish upon completion and acceptance of job. Any necessary refinishing to match original shall be done by Contractor. Do not paint over name plates, serial numbers or other identifying marks.
3. All new piping shall be painted as required in Section 22 and 23. Paint colors shall conform to color code requirements as specified in "Identification of Piping and Equipment".

1.16 EQUIPMENT BASES:

A. Provide reinforced concrete bases under boilers, chillers, pumps, air handling units, and other equipment as necessary or as indicated on the drawings. Coordinate work with Division 03.

B. Bases shall be 6" high, above the finish floor. The base shall extend beyond the equipment 6" in all directions, where possible. Inserts and vibration isolation systems shall be provided and installed by the Mechanical Contractor at the time the concrete is poured to accommodate and anchor the equipment used. Coordinate with vibration isolation manufacturer's requirements and Section 22 and 23. Provide a one inch beveled edge all around.

1.17 BELT GUARDS:

A. Shall be provided, properly enclosing each belt drive system. Guards shall be easily removable, constructed of expanded metal with suitable frames corresponding with SMACNA standard and with tachometer openings. Coordinate with equipment suppliers to avoid duplication of belt guards supplied with equipment. Guards shall comply with OSHA Regulations.

1.18 ELECTRICAL WORK:

A. Power wiring to all electrically driven apparatus shall be done under the electrical contract. See Electrical Specifications.

B. Unless specifically noted otherwise on documents, Electrical Contractor shall furnish and install all magnetic starters including properly sized heaters, and disconnect switches as indicated on drawings or required by code.

C. The Contractor shall verify the proper operation of equipment furnished by him. Costs for repair, replacing, re-wiring and retesting shall be borne by the Contractor without additional costs to the Owner.

D. Motors shall be as specified.

1.19 CONTRACTOR'S USE OF BUILDING EQUIPMENT:

A. The Contractor may use equipment such as electric motors, fans, filters, etc. when permanently installed as part of the project and with the written permission of the Owner. As each piece of equipment is used, maintenance procedures approved by the manufacturer shall be followed, a careful record shall be kept of the time used, maintenance procedure following and of any difficulty experienced with equipment. The Contractor's records on the equipment shall be submitted to the Owner upon acceptance of project. All fan belts and filter media shall be new at the beginning of the Mechanical System Operating Test Run and System Balancing. Wearing surfaces (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement.

1.20 INSPECTION NOTICE:

A. The following is a basic list of guideline items so that the Architect, district building inspector/Owner’s representative can be at job site for these inspections as the building progresses. Mechanical Contractor shall inform these people one week in advance of test time.

1. Water tests on all sewer, waste, and rainwater piping prior to piping being concealed.
2. Pressure tests on all water service piping.
3. Pressure tests on hot, chilled, and condenser water supply and return piping.
4. All duct work prior to installation of finished ceilings, including ductwork pressure testing.
5. The initial start-up of mechanical equipment, etc.
6. Any changes or problems occurring at job site.

7. Inspect all vent flashings on roof prior to roofing.
8. Periodic inspection at their discretion will be made to insure compliance to Contract Documents and codes. Contractor shall provide ladders, access and other assistance as requested during inspections.
9. Control piping pressure tests.
10. Final inspection before giving approval for final payment.

1.21 EXCAVATION AND BACKFILLING:

A. Trench for the underground gas pipe line shall be excavated to the required depth. Rocks, trash, or other debris will not be allowed in trench or backfill and shall be removed before pipe is laid in place. After piping has been tested, inspected and approved, piping shall be backfilled. All landscaping, concrete, etc., damaged by this Contractor shall be replaced by him to the satisfaction of Owner's Representative.

1.22 WARRANTY GUARANTEE:

A. The Contractor shall warrant all materials and equipment to be of quality consistent with specifications as represented by manufacturer's published data.

B. The Contractor shall guarantee that the installation and operation of the equipment shall be free from defects for a period of one year beginning at date of substantial completion and acceptance. The Contractor shall replace or repair any part of the installation that is found to be defective or incomplete within the guarantee period.

C. The one year guarantee on equipment and systems shall commence when equipment has been demonstrated to work and has been accepted. (Example: If an equipment item fails to perform and it takes 9 months after substantial completion to correct, then the guarantee shall commence after the item has been demonstrated to perform and has been accepted.)

D. Substantial completion and acceptance in no way relieves the Contractor from providing the systems and equipment as specified.

1.23 COMPLETION SCHEDULE:

A. Start-up and verification of basic equipment items shall be done prior to the date of substantial completion with sufficient time to allow balancing and adjusting to be performed.

B. At the time of the final inspection a date shall be agreed upon for completion of any remaining items. At least double the estimated cost of the work will be withheld from the Contractor's payment.

1.24 CODE REQUIREMENTS, FEES, AND PERMITS

A. The work shall be installed in accordance with the following applicable codes, ordinances and standards unless otherwise specified. The codes and standards shall include but not be limited to and be of the latest and current editions.

1. American Boiler and Affiliated Industries (AB and AI)
2. American Gas Association (AGA)
3. Air Movement and Control Association (AMCA)
4. American National Standards Institute (ANSI)
5. Air Conditioning & Refrigeration Institute (ARI)
6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - ASHRAE 90.1-2019
7. American Society of Mechanical Engineers (ASME)
8. American Society of Testing Materials (ASTM)
9. American Standards Association (ASA)
10. American Water Works Association (AWWA)
11. American Welding Society (AWS)
12. Associated Air Balance Council (AABC)
13. Heat Exchange Institute (HEI)
14. Hydraulic Institute (HI)
15. BR
16. National Electrical Code (NEC)
17. National Fire Protection Association (NFPA)
18. Sheet Metal and Air Conditioning contractors National Association (SMACNA)
19. Underwriters Laboratories (UL)
20. International Building Code (IBC) 2021 Ed
21. International Mechanical Code (IMC) 2021 Ed
22. International Plumbing Code (IPC) with Utah Amendments 2021 Ed
23. International Energy Conservation Code (IECC) 2021 Ed
24. Utah State Safety Orders (OSHA/UOSH)
25. Utah Fire Rating Bureau
26. Utah Boiler and Pressure Vessel Law
27. Utah Air Conservation Regulations/Waste Disposal regulations.
28. ASHRAE Ventilation STD.62-2019

B. Should drawings conflict with any code, the code shall govern. If drawings and specifications establish a quality exceeding the code, the drawings and specifications shall govern. If conflicts do exist among the drawings, specifications and codes, the same shall be brought to the attention of the Engineer in writing prior to bidding, otherwise Contractor shall comply with applicable codes.

C. The latest edition of all codes shall be used.

D. Contractor shall give all notices, obtain all necessary permits, file necessary plans, prepare documents and obtain approvals, and pay all fees required for completion of the mechanical and plumbing work outlined in this Division of the specifications and shown on the Mechanical Drawings.

1.25 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. Upon completion of work and before final payment, Contractor shall furnish and deliver to the Owner, through the Engineer, installation, operation and maintenance manuals with instructions for all new materials and equipment used in the building. The contractor shall provide three (3) hard copies of the manuals, and three (3) CD's with electronic copies of the manuals. Electronic information shall be .PDF format. The CD's shall include the same information as the hard copies, and shall be organized in the same manner with electronic bookmarks for each section. CD case and the CD itself shall be labeled the same as the hard copies of the manuals.

B. Bind Operation and Maintenance Manual for Mechanical Systems in a hard-backed piano hinge loose-leaf binder with strong sturdy cover. The project name shall be on the spine and the front of the binder. The front of the binder shall include the following information:

OPERATION
AND
MAINTENANCE
MANUAL
for MECHANICAL SYSTEMS of
(Name of Project)
(Location of Project)
(Date of Project Award)
(Name of Architect)

C. Introduction

1. Title page including name of project, project number, date awarded and date of substantial completion.
2. Second page shall contain the names, phone numbers and addresses of Architect, Consulting Engineers, Mechanical Contractor, and General Contractor.
3. Third page shall include a Table of Contents for the entire manual.

D. First Section - Summary information including:

1. First page shall contain the contractor's warranties.
2. Second page shall contain a list of names, addresses and phone numbers of contractors and all sub-contractors and work to which each was assigned.
3. Final page or pages shall contain an equipment list. The list shall contain each item of equipment or material for which a submittal was required giving ID or tag no as contained on the drawings make and model No. Serial No. Identification No. Location in building, function along with the name, address, and phone number of the supplier.

E. Second Section - Mechanical Equipment O&M data including:

1. Mechanical maintenance schedule, including a lubrication list when necessary.
2. Mechanical Equipment Operation and Maintenance Data including:

    a. Equipment descriptions

b. Detailed installation instruction, operating and maintenance instructions. Instructions include in a step by step manner identifying start-up, operating, shutdown and emergency action sequence sufficiently clear so a person unfamiliar with the equipment could perform its operations.
c. Equipment drawings, performance curves, operating characteristics, etc.
d. Name addresses and phone number of manufacturer, fabricator and local vender clearly printed or stamped on cover.
e. Complete parts listing which include catalog number, serial number, contract number or other accurate provision for ordering replacement and spare parts.
f. Certified drawings, where applicable, showing assembly of parts and general dimensions.

3. Approved Mechanical submittals

F. Third Section - Plumbing Equipment O&M data including:

1. Section shall contain general product catalog cuts, as well as exploded view drawings with parts lists for all valves and other items with multiple parts.
2. Approved Plumbing submittals

G. Fourth Section - Controls O&M data including:

1. Sequence of Operation
2. Description of each operating system included location of switches, breakers, thermostats, and control devices. Provide a single line diagram, showing set points, normal operating parameters for all loads, pressures, temperatures and flow check points; Describe all alarms and cautions for operation.
3. Provide schematic control diagrams, panel diagrams, wiring diagrams, etc. for each separate fan system, chilled water system, hot water system, exhaust air system, pumps, etc. Each control diagram shall show a schematic representation of mechanical equipment and location of start-stop switches, insertion thermostats, thermometers, pressure gauges, automatic valves, etc. The correct reading for each control instrument shall be marked on the diagram.

H. The Fifth Section shall contain a complete air and water test and balance report. The report shall contain the name, address and phone number of the agency. It shall also include:

1. Floor plans showing all air openings and thermometer locations clearly marked and cross referenced with data sheets. Format may be 8 1/2 x 11 or 11x14 if legible.
2. Data sheets showing amount of air and water at each setting. See sections 22 and 23.
3. List of equipment with date of last calibration.

I. Drawings and reproducible masters of drawings as required in individual specification sections, are not to be bound in volumes but are to be delivered separate with the maintenance manuals.

J. See the following checklist for assistance in assembling manual:

Item #	Description	Y, N, or NA
1.	3 ring heavy duty binder with Project name, number and date on cover and project name on spine.	
2.	O&M manual on CD (with label on CD matching label on manual). Electronic copy shall be a PDF file with bookmarks that match the tabs in the hard copy.	
3.	Title Page [including project name, number, address, date awarded, date of substantial completion]	
4.	Second Page Contact List [including architect (if applicable), mechanical engineer, mechanical contractor, and general contractor (if applicable)]	
5.	Table of Contents	
6.	Section 1 - Summary	
A.	Warranty	
B.	Mechanical's Sub-contractor List	
C.	Vendor List	
D.	Equipment List	
7.	Section 2 – Mechanical Equipment	
A.	Maintenance Schedule (including lubrication list)	
B.	Mechanical Equipment O&M Data (for each piece of equipment submitted) per specifications	
C.	Approved mechanical submittals	
8.	Section 3 – Plumbing Equipment	
A.	Plumbing equipment O&M data	
B.	Approved plumbing submittals	
9.	Section 4 - Controls	
A.	Sequence of Operation	
B.	Controls diagrams	
C.	Controls Equipment	
10.	Section 5 – Test and Balance Report	
A.	Complete Test and Balance Report per specifications	

1.26 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems utilizing the Operation and Maintenance Manual when so doing.

B. Minimum instruction periods shall be as follows -

1. Mechanical - Four hours.
2. Temperature Control – Four hours.

C. Instruction periods shall occur before final site observation when systems are properly working and before final payment is made.

D. None of these instructional periods shall overlap each other.

E. An additional four hours of instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and answer questions.

1.27 RECORD DRAWINGS

A. Contractor shall keep an up-to-date set of mechanical and plumbing drawings in his custody showing all changes in red, clearly defined and neatly drafted by him. At the end of construction, he shall turn these drawings over to the Engineer. Record drawings must be completed and submitted prior to final site observation

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PART 2 - PRODUCTS
(Not Used)

PART 3 - EXECUTION
(Not Used)

END OF SECTION 230100

SECTION 230500 – BASIC PLUMBING AND HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Mechanical demolition.
7. Equipment installation requirements common to equipment sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. All materials, piping, etc. shall be new, and domestically made of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended unless specifically approved in writing prior to bid.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 and 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Available Manufacturers:

    a. Capitol Manufacturing Co.
    b. Central Plastics Company.
    c. Eclipse, Inc.
    d. Epco Sales, Inc.
    e. Hart Industries, International, Inc.
    f. Watts Industries, Inc.; Water Products Div.
    g. Zurn Industries, Inc.; Wilkins Div.
    h. Prior Approved Equal.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Metraflex Co.
    d. Pipeline Seal and Insulator, Inc.
    e. Linkseal.
    f. Prior Approved Equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

E. PVC Pipe: ASTM D 1785, Schedule 40.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 and 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Drawings do not show every offset, or bend that may be required. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors where indicated on drawings and where penetrating will be visible to public.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 and 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 230500

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Freestanding and restrained spring isolators.
3. Seismic snubbers.
4. Restraining braces and cables.

1.3 SCOPE

A. Provide letter of design intent.

B. Provide full set of seismic submittals.

C. Provide final letter of compliance completion.

1.4 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.5 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: Per owner’s design standards.
2. Building Classification Category: As defined in the IBC.
3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class: As defined in the IBC.
2. Assigned Seismic Use Group or Building Category: As defined in the IBC.

    a. Component Importance Factor: 1.0.

1.6 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Letter of Design intent, stating company, design criteria, compliance with specifications and only exceptions that will apply. Letter shall be stamped and signed by a licensed and qualified professional engineer in this jurisdiction.

C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.

    a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic- and Wind-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing's. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 and 23 Sections for equipment mounted outdoors.
d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

E. Welding certificates.

F. Qualification Data: For professional engineer and testing agency.

G. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Upon project completion provide a final letter of acceptance for seismic restraints system and installation.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Vibro-acoustics.
3. ISAT
4. Mason Industries.
5. Caddy
6. Prior approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Hilti, Inc.
3. ISAT
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibro-acoustics.
7. Unistrut; Tyco International, Ltd.
8. Prior approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: -steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate

with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Leave a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR MECHANICAL AND PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment signs.
3. Access panel and door markers.
4. Pipe markers.
5. Warning tags.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

a. Manufacturer, product name, model number, and serial number.
b. Capacity, operating and power characteristics, and essential data.
c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.
2. Engraving: Manufacturer's standard letter style, 1/4” or larger with terms to match equipment identification.
3. Thickness: 1/8 inch, unless otherwise indicated.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

C. Access Panel and Door Markers: 1/16” thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8” center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Bradley.
b. Kolbi.
c. Prior approved.

2. Colors: Comply with ASME A13.1, unless otherwise indicated.
3. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, furnaces, heaters, etc.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HVAC central-station and zone-type units.

B. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with black equipment markers with white lettering.
2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
4. Include signs for the following general categories of equipment:

    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    b. Fuel-burning units, including boilers, furnaces, heaters, etc.
    c. Pumps, compressors, chillers, condensers, and similar motor-driven units.

d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
e. Fans, blowers, primary balancing dampers, and mixing boxes.
f. Packaged HVAC central-station and zone-type units.
g. Tanks and pressure vessels.
h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

C. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.4 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.5 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:

    a. Constant-volume air systems.

2. HVAC equipment quantitative-performance settings.
3. Verifying that automatic control devices are functioning properly.
4. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service

representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

    a. Submittal distribution requirements.
    b. The Contract Documents examination report.
    c. TAB plan.
    d. Work schedule and Project-site access requirements.
    e. Coordination and cooperation of trades and subcontractors.
    f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. Approved TAB agencies:

1. Bonneville Test and Balance.
2. BTC Services.
3. Certified Test and Balance.
4. Environmental Systems Balancing
5. Intermountain Test and Balance.
6. RS Analysis.
7. Tempco
8. Prior approved equal

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS
(Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.

2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air

Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.7 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.8 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Provide final report on standard AABC or NEBB forms.

3.9 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Measure sound levels at two locations.
e. Measure space pressure of at least 10 percent of locations.
f. Verify that balancing devices are marked with final balance position.
g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.10 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230700 - HVAC AND PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Mineral fiber.

2. Insulating cements.
3. Adhesives.
4. Lagging adhesives.
5. Factory-applied jackets.
6. Field-applied jackets.
7. Tapes.
8. Securements.
9. Corner angles.

B. Related Sections:

1. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 and 23 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors. Provide a weather protective sheet metal jacket for outdoor installation.

2. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; All-Service Duct Wrap.
f. Prior approved equal.

G. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
f. Prior approved equal.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
c. Prior approved equal.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-127.
b. Foster Products Corporation, H. B. Fuller Company; 85-60/ 85-70.
c. Marathon Industries, Inc.; 225.
d. Mon-Eco Industries, Inc.; 22-25.
e. Prior approved equal.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of H.B. Fuller; CR 50 AHV2.
b. Foster Products Corporation, H. B. Fuller Company; 30-36.
c. Vimasco Corporation; 713 and 714.
d. Prior approved equal.

2. Service Temperature Range: Minus 50 to plus 180 deg F.
3. Color: White.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
b. Compac Corp.; 104 and 105.
c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
8. Adhesion: 64 ounces force/inch in width.
9. Elongation: 500 percent.
10. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.
e. Prior approved equal.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.
d. Prior approved equal.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.8 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt

each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe

insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.7 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return, Air.
4. Indoor, exposed return, Air.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, concealed exhaust.
7. Indoor, exposed exhaust.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Concealed, low pressure, round rectangular, and flat-oval exhaust-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Rectangular, low pressure, supply-air duct insulation shall be lined per Section “Metal Ducts”.

D. Rectangular, return-air duct insulation shall be lined per Section “Metal Ducts”.

E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

F. Exposed or medium pressure, round and flat-oval, supply-air, and return air duct insulation shall be a perforated linear. See Section “Metal Ducts”.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
4. Vertical roof drain piping.

C. Piping System insulation:

1. Hydronic Piping - Mineral Fiber, per chart.
2. Domestic Cold Water Piping -Mineral Fiber, ½”
3. Domestic Hot Water Piping -Mineral Fiber, per chart
4. Horizontal Roof Drain Piping - Mineral Fiber, 1/2”.
5. Refrigerant Piping - Flexible elastomeric, 1”.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2019, with modifications per 2021 IECC

Fluid Operating Temperature Range	Insulation Conductivity	Nominal Pipe or Tube Size (inches)

and usage (F°)	Conductivity Btu-in./(h-ft^2-F°)	Mean Rating Temp. F°	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)							
>350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.21-0.28	100	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine, and Refrigerant)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20-0.26	50	0.5	1.0	1.0	1.0	1.5

3.12 DUCT INSULATION SCHEDULE

A. Minimum Duct Insulation R-Value, Cooling and Heating Supply Ducts and Return Ducts ANSI/ASHRAE/IES Standard 90.1-2019.

Duct Location							
Climate Zone	Exterior	Ventilated Attic	Unvented Attic Above Insulated Ceiling	Unvented Attic with Roof Insulation	Unconditioned Space	Indirectly Conditioned Space	Buried
Heating- Only Ducts							
5	R-6	R-3.5	none	none	none	none	R-3.5
Cooling-Only Ducts							
5,6	R-3.5	R-1.9	R-3.5	R-1.9	R-1.9	none	none
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none
Combine Heating and Cooling							
Supply Ducts							
5	R-6	R-6	R-6	R-1.9	R-3.5	none	R-3.5
Return Ducts							
1 to 8	R-3.5	R-3.5	R-3.5	none	none	none	none

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

1. PVC: 20 mils thick.

3.14 OUTDOOR, FIELD APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Exterior piping, Exposed:

1. Aluminum jacket.

END OF SECTION 230700

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.

B. Welding certificates.

C. Field quality-control reports.

D. Operation and Maintenance Data: For pressure regulators to include in operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.
    f. Prior approved equal..

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Vanguard Valves, Inc.
    b. Safe-T-Quake.
    c. Koso
    d. Trembler Tech
    e. Prior approved equal.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded end connections complying with ASME B1.20.1.
8. Wall mounting bracket with bubble level indicator.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Actaris.
    b. American Meter Company.
    c. Fisher Control Valves and Regulators; Division of Emerson Process Management.

d. Invensys.
e. Richards Industries; Jordan Valve Div.
f. Prior approved equal.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Install fittings for changes in direction and branch connections.

E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

F. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

H. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 22 and 23 Section "Meters and Gages."

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install escutcheons at penetrations of interior walls, ceilings, and floors.

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
e. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated or rough-brass finish.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 22 and 23 Section "Meters and Gages."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 and 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 22 and 23 Section "Hangers and Supports."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 and 23 Section "Mechanical Identification" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 9 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

    a. Prime Coat: Alkyd anticorrosive metal primer.
    b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    c. Topcoat: Exterior alkyd enamel (flat).
    d. Color: By owner.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

    a. Prime Coat: Quick-drying alkyd metal primer.
    b. Intermediate Coat: Interior latex matching topcoat.
    c. Topcoat: Interior latex (semigloss).
    d. Color: By owner.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.13 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping shall be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping 2” and larger shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:

1. One-piece, bronze ball valve with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, lubricated plug valve.

END OF SECTION 231123

SECTION 231323 – ABOVE GROUND FUEL STORAGE TANK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Above ground main tank design and product requirements.
2. Piping materials.
3. Fitting and valves.
4. Fuel Pumps.

B. Scope of Supply:
1. Equipment specified herein is intended for the use of fueling District vehicles as well as supplying fuel to the District emergency generator system. Contractor shall be responsible to furnish and install all tanks, pumps, piping, valves, dispensing, fuel control and level monitoring equipment to provide a complete, functional and code-compliant system.
2. System shall be installed and wired such that a minimum fuel capacity shall be reserved for generator consumption for a minimum continuous runtime of 24 hours under full load conditions. When the fuel level in the main storage tank falls below this set-point, vehicular fuel dispensing shall be automatically disengaged.
3. When fuel level rises above setpoint, fuel dispensing operations may be automatically resumed.

1.2 RELATED SECTIONS

A. Section 01 33 00, Submittal Procedures

B. Section 26 32 13, Engine Generators

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

B. National Fire Protection Association (NFPA):
1. NFPA 30 Flammable and Combustible Liquids Code
2. NFPA 54 National Fuel Gas Code

C. Underwriters Laboratories Inc. (UL):
1. UL 142 Steel Above-ground Tanks for Flammable and Combustible Liquids
2. UL 2085 Protected Above-ground Tanks for Flammable and Combustible Liquids
3. UL 971 Standard for Nonmetallic Underground Piping for Flammable and Combustible Liquids

4. UL 971A Standard for Metallic Underground Piping for Flammable and Combustible Liquids
5. UL 1369 Standard for Aboveground Piping for Flammable and Combustible Liquids

D. Environmental Protection Agency

1.4 SUBMITTALS

A. General: Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Submit the following:
1. Shop drawings of tanks, containment basins, level, drains, vents, and connections.
2. Layout and connection diagram showing location of all equipment, vents, grounding requirements, and pipe routing.
3. Tank manufacturer's product data.
4. Certificates of Compliance: Manufacturer shall certify that tank will perform as specified.
5. Test reports.
6. Installation instructions.
7. Tank foundation, mounting and seismic anchoring calculations, and details.

PART 2 - PRODUCTS

2.1 ABOVE GROUND MAIN TANK DESIGN AND PRODUCT REQUIREMENTS

A. Manufacture fuel tank in accordance with UL 2085. Tank shall be capable of storing petroleum products with specific gravity up to 1.1 including fuel oils, specifically No. 2 diesel fuel, at temperatures up to 150 degrees Fahrenheit.

B. Provide useable fuel tank volume of 90 percent. Allow 5 percent for sump volume and 5 percent for expansion. Size tank to store fuel supply for engine generator operating at full capacity 24-hour minimum plus exercising the generator for 30 minutes monthly. Provide supply and return lines from the engine generator.

C. Provide 3-inch fill line with check valve, ball valve, female camlock with cap/plug, and overfill prevention valve with metallic drop tube extending to within 6" of tank bottom, cut at a 45 degree angle. Provide required vents (emergency and vapor) with rainproof caps. Provide high- and low-level alarms, analog tank level instruments, and leak detection. Alarms generated by the fuel storage and circulation systems shall be transmitted to OCC as well as a local audible alarm.

D. Provide Gasboy Atlas Electronic Single Hose Suction Pump/Dispenser with TopKAT plus fuel management system.

E. The internal steel tank shall pass a 5 psig pressure test for a 24-hour period at the factory.

F. Tank(s) shall be tested in accordance with the Uniform Fire Code, Appendix llF, Proposed Test Requirements for Protected Tanks: Standard 79-7 (including impact and ballistic tests).

G. The primary and secondary tanks shall have an emergency vent as required by the NFPA and Uniform Fire Code.

H. The primary tank shall be equipped with a normal vent with flame-arresting vent cap, equal or greater size than the fill or withdraw fittings, whichever is greater. Vent cap shall terminate at 12' above finished grade.

I. The secondary containment shall have the capability of physical monitoring. Physical monitoring shall be accomplished using an engineer approved leak detection system. External tank connections shall be equal to or larger than 2 inch.

J. The tank shall have an outer steel tank that encompasses 360 degrees of the internal tank.

K. The internal and external steel tanks shall have continuous welds on all sides.

L. The steel tank openings shall be threaded except for the leak detector tubes.

M. The tank shall be equipped with an end-mounted ladder with handrail for safe access to tank top.

N. The tank shall have a saddle support system that meets UBC Zone 4 seismic requirements.

O. Acceptable Manufacturers

1. Double Wall UL-142, 20,000 gallon diesel tank
2. Or Equal

P. Tanks shall have warning signs to indicate COMBUSTIBLE, NO SMOKING, a NFPA Placard H=0, F=2, R=0 and No. 2 diesel.

2.2 PIPING MATERIALS

A. All above ground piping shall be ASTM A53, schedule 40 black steel pipe, or UL 1369 listed flexible piping system with a minimum 2-hour fire rating. DoubleTrac by OmegaFlex or Engineer approved equal.

B. All below grade piping shall be UL-971/971A double-wall flexible pipe. DoubleTrac by OmegaFlex or Engineer approved equal.

2.3 SUMP TRANSITION BOXES

A. Provide grade level transition sumps at fuel station and generator.

2.4 FITTINGS AND VALVES

A. All black iron pipe fittings shall be ANSI B16.3, Class 150 banded, malleable iron, threaded. Connections between dissimilar pipe materials shall be isolated with insulating flanges, unions, or gaskets as necessary.

B. Foot Valve: Single Poppet, Bronze Body with 20 Mesh Strainer
   1. Set at 2" from tank bottom

C. First valve/fitting off the tank outlet on both the fuel dispensing and generator supply lines shall be a Fusible Emergency Valve. Fusible emergency valve shall be ductile-iron or stainless steel construction, with a spring-loaded fusible link with 165 degree F melting point.

D. Fuel shutoff valves at the tank(s) shall be ball valves. Valves shall be brass or bronze bodied, stainless steel shaft, chrome plated or stainless steel ball with Teflon seat. Valves shall be rated at 150 psig WOG.

E. Check valves shall be swing type, 150 psig rated, threaded, brass or bronze bodied, with removable stainless steel hinge pin and screwed cap.

F. Pressure relief valves shall be 150 psig rated, threaded, brass or bronze bodied, and be adjustable from 20 to 100 psig.

G. Anti-siphon valve(s): PUMC Type A, Universal 403, EBW 616-300 or equal.
   1. Dispensing Anti-Siphon Valve shall be 120vAC Solenoid Valve, Normally Closed, with Bronze Body and Explosion-proof outdoor rated coil with Class F insulation.
   2. Generator Supply Anti-Siphon Valve shall be 24vDC Solenoid Valve, Normally Closed, with Bronze Body and Explosion-proof outdoor rated coil with Class F insulation.
      a. Generator supply valve shall have a manual bypass valve in accordance with NFPA 37.
   3. Solenoid valves shall be Universal Valve Series 404V, or approved equal

H. Flexible Connector: Stainless steel braided flex connector, UL Listed for Aboveground use with flammable and combustible liquids. No plated fittings.
   1. Swivel shall be rated for 100 PSIG.

I. Provision for tank grounding shall be provided.

2.5 FUEL TANK MONITORING

A. Tank Fuel level, tank high and low level alarms, and containment leak detection shall be monitored from one console.

B. CONSOLE:
   1. OMNTEC Proteus K-SS series console or equal.
   2. Operating temperature: -22 °F to 140 °F
   3. Enclosure Rating: NEMA 4X
   4. Power Requirements: 100-240 VAC

5. Memory: Configuration/Setup Data – EEPROM, 50 year data retention, no batteries
6. Log Reports and Real-Time Clock – Lithium Battery-Backed RAM, 5-10 year data retention
7. Audible Alarm: 85 db
8. Display: 7" Color Graphic Display with Capacitive Touchscreen, Power, Warning and Alarm LED's
9. Communications: RS-232 Included Standard, (2) Configurable RS-232/RS-485 Comm Ports, RJ-45 TCP/IP PortModBus shall be transmissible from any/all Comm Ports
10. Probe / Sensor Capacities: 4/16(Probes/Sensors) All Sensor Inputs Supervised-Wiring-Ready
11. I/O, Non-Haz.::
    a. 5 On-Board Output Relays, Form C, Rated 6 A@120
    b. 2 On-Board Input Relays for Remote Generator / Fuel Pump Monitoring
    c. 8-Output External Relay Module capable, connected via RS-232 port
    d. 2, 6 or 12-Ch. Programmable Analog Outputs:
        1) 0-1 mA, 0-20 mA, 0-24 mA, 4-20 mA, 0-5 VDC, 1-5 VDC
        2) Configurable for Tank Fuel Level, Water Level or Fuel Temperature

C. Probe:
1. Probe:Magnetostrictive, Dual Float, w/ reflection resolution doubling
2. Accuracy (Minimum): MTG-RS-R5F2:
    a. Product Level: 0.0005" (0.013 mm)
    b. Water Level: 0.001" (0.025 mm)
    c. Temperature: 0.001 ºF (0.0006 ºC)
3. Materials:
    a. Shaft: 316 SS
    b. Floats: 316 SS
4. Mounting:
    a. In-Tank Leak Testing: 4" (102mm) diameter riser
    b. Inventory Only: 2" (51 mm) minimum riser or direct bushing / flange mount
5. Temperature Sensing: 5 Thermistors in shaft, 1 in probe head
6. Location Approval: UL Class I, Div 1, Groups C and D; cUL Class I, Zone 0, Group IIB
7. Operating Temperature: -40 ºF to 175 ºF (-40 ºC to 80 ºC)
8. Operating Pressure: 150 PSIG (1034 kPa) 316 SS, 50 PSIG (345 kPa) PVDF
9. Field Wiring:
    a. 22AWG, 2-Conductor twisted pair w/ shield
    b. Omntec EC-2, Belden 8761, or equiv., max. length 1000'
10. Models:
    a. MTG-RS-R5F2 Series rigid SS max. length 24' (7.3 m)

D. SENSORS
1. BX-PDWS:
    a. Electronic, Discriminating - Containment, Manway and Piping Sumps, Dispenser Pan, Dry Annular, Includes Fault Detection Feature as Standard
2. BX-LWS:
    a. Electronic, Non-Discriminating - Containment, Manway and Piping Sumps, Dispenser Pan, Dry Annular, Includes Fault Detection Feature as Standard
3. LF-X (X = Number of Set Points)

a. Multi-Float, High / Low Level and Pump Control

E. REMOTE DISPLAYS
1. Mini-Me: Addressable TCP/IP Remote Electronic Tank Display Panel, 7" Touchscreen, capable of displaying all level and alarm conditions as shown on the main console

2.6 FUEL DISPENSER AND MANAGEMENT SYSTEM

A. Fuel dispenser shall be a Gasboy AtlasX Electronic Suction Pump, equipped with a TopKAT Fuel Control System, or equal:

B. Suction Pump:
1. Configuration: Suction Pump, Single Product, Single Hose
2. Flow Rate: 22 GPM
3. Display: Electronic Fleet with Gallons Display and non-resettable Totalizer
4. Meter: Four-piston positive displacement flow-through CFT meter
5. Motor: 1 HP Continuous Duty Explosion-proof rated
6. Internal Filter: Spin-On Filter, Hydrosorb II
7. Flow Control Valve: 2-Stage 1" Solenoid
8. Inlet Connection: 1-1/2" NPT
9. Model: Gasboy Atlas 9853K

C. TopKAT Plus System:
1. Supply voltage: 120/240 VAC
2. Power consumption: 1A max
3. Operating temperature: -40 °F to +104 °F (-40°C to +40 °C)
4. Storage temperature: -40 °F to +158 °F (-40°C to +70 °C)
5. Humidity: 80% non-condensing
6. Dimensions: 16.55"W x 11.39"H x 20.47"D (420.4 x 289.4 x 520 mm)
7. Communication interface: RS-485 – 9600bps, Half-Duplex, RS-232 Ethernet RJ-45 – 10 Mbps
8. Pump control maximum current (2 solid state Relay Channels): Motor maximum: ¾ HP at 115 VAC factory installed – switches motor relays
9. Power supply output voltage to pulsar unit: 12 VDC +/- 20%
10. Pulsar supply maximum output current: 30 mA max
11. Pulsar input high level voltage: 9 to 15 VDC
12. Pulsar input high level sink current (@15V): 3 mA
13. In-use "on" level (input): 100-240 VAC, 50/60Hz, 2 W (20 mA)
14. In use "off" level (input): 0 to 20 VAC.
1. D. Hanging Hardware:Hose: 3/4" x 14' Curb Pump Hardwall Dispensing Hose, Green, with Swivel on Both Ends. VSTaflex V34CPG or equal
2. Whip Hose: 3/4" x 9" Curb Pump Whip Hose, Green. VSTaFlex V10CPG or equal
3. Nozzle: ECO Diesel Spitless/Dripless Diesel Nozzle. VST ECO Nozzle VST-DS-NDGN or equal
4. Breakaway: ¾" Field-reattachable Safety Breakaway, VST VST-CP-SBK or equal
5. Hose Retractor: Counterweight hose retractor. Universal Valve 882 or equal

2.7 SCADA MONITORING

A. System shall have the information available for monitoring via Ethernet to the SCADA System
   1. Data map shall be provided as part of the submittal.
   2. Ethernet protocol shall be Modbus TCP.
   3. All Analog Values, operation data etc. shall be available to the SCADA interface.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install tanks and fuel distribution system as indicated, and in accordance with NFPA 30 and the manufacturer's installation instructions.

B. Provide earthquake restraints on fuel tank.

C. Mount fuel tank(s) concrete slab as shown on drawings to support the loads.

3.2 FIELD QUALITY CONTROL

A. Prior to engine generator testing, tanks and piping shall be tested in the presence of the Engineer as follows:
   1. Air Test: Tank(s) and associated piping shall be pressurized with air to 5 psig for a minimum of 24 hours. The tank(s), fittings, and pipings shall have no more than a 1 psig drop over a period of 24 hours. Air gage shall be calibrated in 1/4 psig increments. Temperature shall be constant during the air test.
   2. Soap Test: With tank(s) and associated piping pressurized at 5 psig, a one to two percent solution of household detergent in water shall be applied to exterior surface of tank with sponge or other acceptable means. Leaks revealed by bubbling of soap film shall be marked and, after tank is depressurized, repaired and retested until there are no leaks.
   3. After testing, tank(s) and appurtenances shall be thoroughly cleaned and dried.

END OF SECTION 23 13 23

SECTION 232123 – HYDRONIC PUMPS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. Provide pumps and required system trim for heating, chilled water, and dual temperature water systems including all related appurtenances for a complete and operating system.

1.2 SECTION INCLUDES

A. Close Coupled, Vertical Inline Pump

1.3 RELATED SECTIONS

A. Drawings and general provisions of the contract, including general and supplementary Conditions and Division 1 Specification Sections, apply to these Sections:
   - Section 033000 - Cast-in-Place Concrete
   - Section 220010 - Mechanical General Requirements
   - Section 220553 - Mechanical Identification
   - Section 220719 - Piping Insulation

1.4 REFERENCES

A. HI - Hydraulic Institute.

B. ANSI - American National Standards Institute.

C. OSHA - Occupational Safety & Health Administration.

D. ASHRAE – American Society of Heating, Refrigeration and Air-Conditioning Engineers.

E. NEMA - National Electrical Manufacturers Association.

F. UL - Underwriters Laboratories.

G. ETL - Electrical Testing Laboratories.

H. CSA - Canadian Standards Association.

I. NEC - National Electric Codes.

J. ISO - International Standards Organization.

K. IEC - International Electrotechnical Commission.

L. ASME – American Society of Mechanical Engineers.

SUBMITTAL

A. Submit each item in this article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Submit manufacturer's installation instructions under provisions of General Conditions and Division 1.

1.5

C. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts lists.

D. Under provisions of commissioning documentation, testing of pumps, as well as training of owner's operation and maintenance personnel may be required in cooperation with the commissioning consultant.

E. Product Data including certified performance curves and rated capacities of selected model, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate pump's operating point on curves.

F. Complete Package information Product Data including:
- System summary sheet (where applicable)
- Sequence of Operation
- Shop drawing indicating dimensions, required clearances and location and size of each field connection
- Power and control wiring diagram
- System profile analysis including pump curves, system curve, and variable speed pump curves (where applicable)
- Pump data sheets - Rated capacities of selected models and indication of pump's operating point on curves.
- Submittals on furnished specialties and accessories
- Submittals must be specific to this project. Generic submittals will not be accepted.

G. A detailed weighted average pump efficiency-Part Load Efficiency Value (PLEV) - Pump Rating Report shall be submitted for each pump. Pump PLEV shall be based on the standard load profile developed in AHRI 550/590-1998 also known as IPLV or Integrated Part Load Value. The pump PLEV Rating shall be based points A: 100%, B: 75%, C: 50% and D: 25% with each Pump Efficiency ratings shown with flow matched to load percentage and Specified Control Head.

H. Specified Control Head shall be 30% TDH or calculated minimum control head specified within the equipment schedule

I. Pump PLEV shall be expressed with load weighting Pump PLEV = 1 / (0.01/A+0.42/B+0.45/C+0.12/D) where

A= Pump Efficiency at 100%

B= Pump Efficiency at 75%

C= Pump Efficiency at 50%

D= Pump Efficiency at 25%

Actual job specific load profile weighting may be substituted for standard IPLV weighting.

J. Hanging and support requirements should follow the recommendations in the manufacturer's installation instructions.

K. Submittals that are "rejected" as being "non-compliant" will be re-reviewed once with all time for subsequent reviews back charged to the contractor in accordance with the engineer's current prevailing rate schedule. If a rate schedule for additional services is included, as part of the contract with the owner that rate schedule shall be used in lieu of the "current prevailing" rate schedule.

1.6 QUALITY ASSURANCE

A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.

B. Ensure pump operation, at specified system fluid temperatures without vapor binding and cavitation, is non-overloading in parallel or individual operation, and operates to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.

C. Ensure pump pressure ratings are at least equal to system's maximum operating pressure at point where installed but not less than specified.

D. Equipment manufacturer shall be a company specializing in manufacture, assembly, and field performance of provided equipment with a minimum of 20 years experience.

E. Equipment provider shall be responsible for providing certified equipment start-up and, when noted, an in the field certified training session. New pump start-up shall be for the purpose of determining pump alignment, lubrication, voltage, and amperage readings. All proper electrical connections, pump's balance, discharge and suction gauge readings, and adjustment of head, if required. A copy of the start-up report shall be made and sent to both the contractor and to the Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site in such a matter as to protect the materials from shipping and handling damage. Provide materials on factory provided shipping skids and lifting lugs if required for handling. Materials damaged by the elements should be packaged in such a matter that they could withstand short-term exposure to the elements during transportation.

B. Store materials in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage.

C. Use all means necessary to protect equipment before, during, and after installation.

D. All scratched, dented, and otherwise damaged units shall be repaired or replaced as directed by the Architect Engineer.

WARRANTY:

A. Provide a minimum One (1) year warranty on materials and installation under provision of Section 01 78 36

PRODUCTS

1.8

MANUFACTURERS

PART 2 A. Acceptable Manufactures:

2.1 1. Bell & Gosset, Pump Serires e-80

2. Or Equal

B. Contractor shall furnish and install new close-coupled vertical inline pump for chilled water and hot water heating systems as indicated on the drawings. Pumps shall be Series e-80 as manufactured by Bell & Gossett or equal. Equivalent units as manufactured by other manufacturers may be submitted as deduct alternates. Pumps shall meet types, sizes, capacities, and characteristics as scheduled on the Equipment Schedule drawings. Pump substitutions shall be provided with connection sizes equal to those scheduled. Pump connections shall not be downsized. Pump substitutions shall not be provided at efficiencies less than those scheduled.

2.2 COMPONENTS

A. The pumps shall be close-coupled, inline for vertical or horizontal installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure (or optional operations at up to 250°F and 250 PSIG working pressures). Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.

B. As an option an EPR/Carbon/Tungsten/Carbide/SS seal (250°F maximum operating temperature), FKM/Carbon/Ceramic/SS seal, or EPR-Silicon Carbide/Silicon Carbide/SS seal may be used in lieu of the standard Buna/Carbon/Ceramic/SS seal (225° F maximum operating temperature).

C. The pumps shall have a solid alloy steel shaft that is integral to the motor. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.

D. The motor bearings shall support the shaft via heavy-duty grease lubricated ball bearings.

E. Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have a stainless steel housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face. (As an option, a stuffing box designed may be used in lieu of the traditional internally flushed mechanical seal design. Pump shall be flushed single seal, flushed double seal, or packing gland type seal arrangements.)

F. Pump shaft shall connect to a stainless steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.-2016. The allowable

residual imbalance conforms to ANSI grade G6.3, keyed to the shaft and secured by a stainless steel locking capscrew or nut.

G. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.

H. Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges (Optional 250 and 300 PSIG working pressures are available and are 250# flange drilled). Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.

I. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall have heavy-duty grease lubricated ball bearings to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.

J. Pumps shall conform to ANSI/HI 9.6.3.1-2012 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.

K. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.

L. Pump manufacturer shall be ISO-9001 certified.

M. Each pump shall be factory tested and name-plated before shipment.

N. As an option, the pump may include an internal stainless steel casing wear rings.

O. Where noted on schedule pumping equipment may require one or all of the following optional tests: Certified Lab tests (unwitnessed), Hydraulic Institute Level B tests, or Witnessed Tests.

2.3 ACCESSORIES

A. Where noted on the schedule, provide one mechanical seal for each model type of primary pump.

B. Where noted on schedule a Bell & Gossett Sediment Separator shall be furnished for installation on the flushing line between the pump discharge flange and the seal area. The sediment separator is installed to increase the overall life expectancy of the seal on inherently dirty systems. The separator shall remove dissolved solids from the flushing medium before the fluid enters the seal area where it can damage and shorten the life of the seal.

C. Where noted on schedule a Bell & Gossett Brazed Plate Heat Exchanger Kit shall be furnished for installation on the flushing line between the pump discharge flange and the seal area. The heat exchanger is installed to increase the overall life expectancy of the seal on high temperature systems (greater than 225° F). The kit shall decrease the temperature of the flushing water being provided to the seal area as a flushing medium to a temperature less than 225° F. Flushing temperatures higher than 225° F can damage and shorten the life of the seal.

INTEGRATED VFD WITH SENSORLESS PUMP CONTROL

A. Integrated Pump Controller shall be factory mounted, wired, with a mains disconnect switch and menu-driven graphical interface.

B. Integrated Pump Controller shall provide near unity displacement power factor (cos Ø) without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls.

2.4

C. Integrated Pump Controller shall include dual DC link reactors equivalent to 5% impedance line reactors, for reduction of mains borne harmonic currents and DC link ripple current to increase DC link capacitor lifetime.

D. Integrated Pump Controller shall have EMI/RFI filters conforming to DIN EN61800-3 to ensure integrated controls meets low emission and immunity requirements.

E. System pressure to be maintained: 25 feet head minimum.

F. Integrated Pump Controller orientation options shall be submitted to engineer for selection.

G. Integrated Pump Controller shall support direct communication with the building management system (BMS) with built-in support for the following protocols: Modbus RTU

H. Integrated Pump Controller shall be provided in an Enclosure rated to UL Type 12 suitable for indoor operation.

I. Integrated Pump Controller shall support Programmable skip Frequencies and adjustable switching frequency for noise and vibration control.

J. Integrated Pump Controller shall provide a temperature controlled Fan for cooling of the heat sink in the back panel.

K. Integrated Pump Controller shall be rated to operate in ambient working conditions of 14°F to +113°F, up to [4220] feet above sea level.

L. Integrated Pump Controller shall provide 2 Analog inputs (current or voltage) and 1 current output.

M. Integrated Pump Controller shall provide 6 programmable Digital inputs with 2 configurable as outputs.

N. Integrated Pump Controller shall support 2 programmable pulse inputs

O. Integrated Pump Controller shall provide 2 programmable relay outputs

P. Integrated Pump Controller shall provide 1 RS485 communication port

Q. Integrated Pump Controller system software shall be capable of sensorless control in variable volume systems without need for pump mounted (internal/external) or remotely mounted differential pressure sensor.

R. Integrated Pump Controller Sensorless control shall operate under Quadratic Pressure Control (QPC) to ensure head reduction with reducing flow conforms to quadratic control curve.

S. Integrated Pump Controller shall support a minimum head of 40% of design duty head.

T. Integrated Pump Controller shall provide user adjustable control mode settings and minimum/maximum head set points using built-in programming interface.

U. Integrated Pump Controller integrated control software shall be capable of controlling pump performance for non-overloading power at every point of operation.

V. Integrated Pump Controller integrated control software shall be capable of maintaining flow rate data.

EXECUTION

PART 3 INSTALLATION

3.1

A. Install equipment in accordance with manufacturer's instructions.

B. Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.

C. Furnish and install triple duty valves on the discharge side of all pumps and furnish and install a line size shut-off valve on the suction side of all pumps. Anywhere that 5 straight pipe diameters of pipe cannot be provided on the inlet side of a pump a suction diffuser shall be used to provide appropriate flow distribution into the eye of the pump's impeller.

D. Provide temperature and pressure gauges where and as detailed or directed.

E. On systems where pump seals require flushing water or cooling water for a heat exchanger kit, provide cooling water supply piping and connections as well as the return piping, if required. Piping should be of adequate size to pass the required flow rate.

F. Proper access space around a device should be left for servicing the component. No less than the minimum recommended by the manufacturer.

G. Provide an adequate number of isolation valves for service and maintenance of the system and its components.

H. Circulating pump shall have sufficient capacity to circulate the scheduled GPM against the scheduled external head (feet) with the horsepower and speed as scheduled and/or as denoted on the drawings. Motors shall be of electrical characteristics as scheduled, denoted and/or as indicated on the electrical plans and specifications. Pump characteristics shall be such that the head of the pump under varying conditions shall not exceed the rated horsepower of the drive motor.

I. On systems where the final balancing procedure requires the triple duty valve to be throttled more than 25% to attain design flow (on a constant speed pumping system), and no future capacity has been built into the pump, the pump impeller must be trimmed to represent actual system head resistance. The pump provider and engineer of record, based on the balancing contractor's reports, shall determine the final impeller trim diameter.

J. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

K. On components that require draining, contractor must provide piping to and discharging into appropriate drains.

L. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instruction and applicable state, federal, and local codes.

M. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the control's contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal, and local codes.

END OF SECTION 232123

SECTION 233100 - FIBERGLASS REINFORCED DUCT AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install fiberglass reinforced plastic (FRP) duct and all appurtenances, complete and in place, all in accordance with the requirements of the Drawings.

B. Section Includes:
   1. FRP Piping
   2. FRP Accessories

1.2 RELATED SPECIFICATIONS

A. Section 220529 – Hangers and Supports for Piping and Equipment

1.3 REFERENCED SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein, are specified in Section entitled “Reference Standards.”

B. Commercial Standards
   1. ASTM D 3567 - Practice for Determining Dimensions of “Fiberglass” (Glass-Fiber Reinforced-Thermosetting-Resin) Pipe and Fittings
   2. ASTM C 582 - Standard Specification for Contact - Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion - Resistant Equipment.
   3. AWWA M-45 - American Water Works Manual of Water Supply Practices "Fiberglass Pipe Design"
   4. ASTM D 3982 - “Standard Specification for Contact Molded “Fiberglass” Duct and Hoods” or NBS PS 15-69 “Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment”
   5. ASTM D 2992 – “Standard Practice for Obtaining Hydrostatic Design Basis for Fiberglass Pipe and Fittings”
   6. ASTM D 2310 – “Standard Classification for Machine-Made Fiberglass Pipe”

1.4 SUBMITTALS

A. Shop Drawings
   1. The Contractor shall submit Shop Drawings of duct and fittings in accordance with the requirements in the Sections titled “Piping, General” and “Submittals”.
   2. Fabrication drawings shall have details on Laminate Sequence used.

B. Additional Submittal Information: The following items shall be submitted:
   1. A letter from the resin supplier stating that the material used for this project complies with the specification and meet all corrosion requirements.

2. Design calculations performed by the manufacturer and stamped by a Professional Engineer for record purposes.
3. Duct manufacturer shall submit certified test results in accordance with ASTM 2992. Engineer will confirm that supplier has completed ASTM 2992 testing.
4. Samples shall be representative of the ductwork (construction method and material used) to be supplied on this project

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturer: Provide FRP duct as manufactured by one of the following:
1. Belco Manufacturing Company, Inc.
2. Ershigs, Inc.
3. NOV Fiber Glass Systems
4. Smith Fibercast, a Varco Company
5. Or equal.

B. Service conditions:
1. All equipment shall be designed for a minimum working pressure of 12" WC Positive and 12" WC Negative pressure. Buried duct shall be designed per AWWA M-45 Standards and be rated for H-20 Loading. The minimum wall thickness for all FRP duct shall conform to the following:
   a. Wall thickness for internal positive pressure should be determined by ASTM 2310 using duct manufacturers Certified ASTM 2992 HDB test results. A full copy of the HDB testing should be submitted with the wall thickness calculations.
   b. Minimum wall thickness shall be as follows:

Duct Inside Diameter (inches)	Minimum Wall Thickness (inches)
3 - 16	0.1875
18 - 24	0.220
30 - 36	0.250

2. The fiberglass reinforced plastic (FRP) ductwork shall be designed and fabricated for odor control service to carry warm, moisture-laden air with hydrogen sulfide, mercaptans and other organic and inorganic compounds typically associated with wastewater treatment.
3. Resin:
   a. Resin shall be premium corrosion resistant and fire retardant brominated vinyl ester. Resin shall not contain pigments, dyes, colorants or fillers. Product should have a class 1 flame spread rating (25 or less).
   b. Thixotropic agents may be added to control resin viscosity per resin manufacturer's recommendation.
   c. Acceptable resins shall be:
      1) AOC Vipel K022
      2) Ashland Chemical Hetron FR992
      3) Interplastics CoRezyn 8442.
      4) Or approved equal.

4. Reinforcement:
    a. Surfacing veil shall be C glass veil with a silane finish and a styrene soluble binder.
    b. Chopped strand mat shall be Type E glass minimum 1-1/2 ounces per square foot with silane finish and styrene soluble binder.
    c. Continuous roving for chopper gun spray up shall be Type E glass.
    d. Woven roving shall be Type E glass minimum 24 ounces per square yard with a five by four weave.
    e. Continuous roving for filament winding shall be Type E glass with a silane finish.

C. Construction:

1. All FRP ductwork shall be of filament wound construction for sizes >10" diameter and hand lay-up or filament wound construction for 10" and smaller. Cast pipe with no reinforced internal corrosion barrier or press molded fittings will not be accepted.
2. Maximum allowable deflection for any size ductwork shall be ½ inch between supports and for any size of duct under worse case operating conditions.
3. FRP ductwork shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum without exception.
4. Out-of-roundness of duct shall be limited to 1% of the diameter.
5. Length of all flanged duct sections shall not vary more than ± 1/2 inch at 70 F.
6. All un-flanged duct shall be square on the ends in relation to the center axis within
7. ± 1/8 inch up to and including 24-inch diameter and within ± 3/16 inch for all diameters greater than 24-inch.
8. Laminates:
    a. All ductwork shall have a resin-rich inner surface, an interior corrosion barrier, an interior structural layer and an exterior corrosion layer and UV resistant coating.
    b. Inner surface: Nominal 10 mils thick composed of a single ply of the C glass surfacing veil embedded in a resin-rich surface. Resin content shall be 90%.
    c. Interior layer: Nominal 90 mils thick composed of at least two layers of chopped strand mat or equivalent chopped strand. Resin content shall be 75%.
    d. Structural layer: Type E glass to meet minimum wall thickness as specified. The total wall thickness includes the inner surface.
        1) Contact molded structural layer shall include alternate layers of chopped strand mat and woven roving.
        2) Filament wound structural layer shall be preceded by a layer of chopped strand mat or spray chop. The structural layer shall consist of a minimum of two complete cross hatched layers of continuous filaments applied in a helix angle of 55 to 65 degrees for above-ground ductwork and 75 deg. for any buried ductwork.
    e. Exterior corrosion layer: Single A or C Veil shall be applied to all duct exterior
    f. Exterior UV resistant coating: Factory applied paraffinated gel coat with UV inhibitors.

9. Fittings:
    a. All fittings shall be hand lay-up construction fabricated from the same resin and have the same strength as hand lay-up FRP ductwork.
    b. The internal diameter of all fittings shall be equal to the adjacent duct.
    c. The tolerance on angles of all fittings shall be ±1 degree up to and including 24 inch diameter and ± 1/2 degree for 30 inch diameter and above.

10. Elbows:
    a. The centerline radius of all elbows shall be 1-1/2 times the diameter.
    b. Elbows 24-inch diameter and smaller shall be smooth radius. Elbows 30- inch and larger shall be mitered. Provide a minimum of two mitered joints (3-piece) for all elbows above 45 Deg.

11. Flanges:
    a. Provide flanged connections to flexible connectors, expansion joints, vessels, demisters, fans, silencers and other locations as shown on the drawings.
    b. Flanges shall be hand lay-up construction. Dimensions shall be in accordance with ASTM D 3982, Table 1, and the Duct Dimension Schedule.
    c. Flanges shall be drilled in accordance with ASTM D 3982, Table 1. Backs of flange face shall be flat so that washer seats fully on bolt face and flange backing.
    d. Flange tolerances shall be in ASTM D 3982, Section 8, Tolerances.
    e. Gaskets shall be EPDM, full face and minimum 1/8 inch thickness.
    f. All bolts, nuts and washers shall be Type 316 stainless steel.

12. Joints:
    a. Provide all butt and strap joints in accordance with ASTM D 3982, Table 2, and manufacturer's drawings.
    b. Field weld kits shall be supplied by the duct manufacturer. All necessary fiberglass and reinforcing material shall be supplied pre-cut and individually packaged for each joint. Bulk Glass rolls will not be acceptable.
    c. All resin, catalyst and putty shall be supplied in quantities to complete all field joints plus 20% extra for waste.

13. Flexible Connectors:
    a. Furnish flexible connectors at each inlet and outlet of fan and in the duct runs where required for expansion, contraction and movement. Flexible connections shall be integral flange molded arch type units constructed of EPDM rubber 1/4-in thick, reinforced with a strong synthetic asbestos-free fabric suitable for corrosive service. The flexible connections shall be designed to minimize the transition of vibration from the fan to the ductwork at the suction and discharge connections. Expansion or contraction flexible connections shall be designed to allow 1-in movement. Working length or "live" length shall be as designed by the manufacturer to allow up to 1-in of movement. Ends shall be flanged, with flanges matching duct connection flanges. Corners on rectangular expansion joints shall be molded and free of patches or splices. The flexible connections shall be suitable for outdoor service and temperature ranges from minus 10 up to 125 degrees F, and pressure to 5 psig. Specially fabricated split type 316 stainless steel retaining back-up bars shall be supplied to prevent damage to the EPDM rubber flanges when type 316 stainless steel bolts are tightened.
    b. Where the construction of the flexible connections or vibration isolator results in a cross-sectional area of the connection which is less than 90 percent of the adjacent ductwork, the size of the connection shall be increased to provide a cross sectional area equal to or greater than 90 percent of the adjacent duct.
    c. Provide flexible duct connections at both the intake and discharge connections for fans except as noted below.
        1) Fans that have integral motor/fan wheel isolation

d. Ductwork spacing and alignment for flexible connections shall be aligned to the tolerances of the flexible connection manufacturer, or plus/minus 1/4-in whichever is less. Bolts shall be torque to the manufacture's recommendations. Do not over tighten.
e. Where flexible connections are used as expansion joints, the manufacturer's compression recommendations must be followed. When the temperature at installation differs from the temperature in the compression recommendation, a correction shall be made.
f. Manufacturer: 1. Holz Rubber Company 2. Mercer Rubber Company 3. Proco Products, Incorporated 4. Or equal

2.2 BUTTERFLY DAMPERS

A. Round Fiberglass Reinforced Plastic Dampers
1. All round FRP dampers shall be the butterfly type. FRP fabrication shall meet the corrosion requirements specified in this Section for FRP duct work.
2. Leakage shall not exceed 3.0 cfm/sq. ft at 12" W.C. and 5.25 cfm/sq. ft at 30" W.C. for Isolation. Unless otherwise specified on the drawings, all dampers are assumed to be Isolation.
3. Fabrication:
   a. Frame and blade: premium vinyl ester. Blade shall fully encapsulate shaft. Blades that bolt to a single side of the shaft will NOT be accepted.
   b. Shaft: Type 316 stainless steel for all dampers.
   c. Bearings and bushings: Teflon.
   d. Pins and all hardware: Type 316 stainless steel.
   e. Shaft seals: EPDM.
   f. Provide all round isolation dampers with a blade stop consisting of FRP angles with full circumference EPDM seals.
   g. Dampers shall have flanged ends where shown on the drawings. Contractor to provide connecting bolts, nuts and washers.
   h. Dampers below 24" shall be supplied with hand quadrant actuators fabricated of Type 316 stainless steel with a 5-stage locking quadrant Indicator. All balancing dampers shall have a fully adjustable slot with an extra hole drilled in the handle for contractor to "drill and pin-in place" once system is balanced so handle cannot vibrate loose. Dampers 24" or larger shall be provided with gear operators with an epoxy coating.
   i. FRP dampers shall be manufactured by Swartwout, Division of Phillips Industries, Belco Manufacturing, Ershigs or equal.
   j. All Isolation dampers provided shall bear the AMCA seal. Dampers are to have been tested in an AMCA laboratory for performance (pressure drop) and leakage.
   k. Dampers may be tested after installation to confirm compliance.
4. The damper shall be warranted for eighteen (18) months from the date of shipment to be free from defects in manufacturing, materials, or workmanship.
5. Where dampers are electrically actuated, motors shall meet the requirements of Section 400557 of the Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: All FRP pipes shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary, all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. All installations shall be acceptable to the Engineer. Contractor shall obtain training by the pipe manufacturer's field representative in the correct installation and support of all FRP piping.

B. Supports and Anchors: All ducting shall be firmly supported with fabricated or commercial hangers or supports in accordance with the requirements in Section 220529, "Hangers and Supports for Piping and Equipment". Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for duct expansion due to temperature differences.

3.2 PIPE PREPARATIONS

A. Prior to installation, each duct length and all fittings shall be carefully inspected, flushed clean of any debris or dust, and straightened, if not true. All duct and fittings shall be equally cleaned before assembly.

3.3 PIPE JOINTS

A. Butt and Wrap Joints: Prior to joining, ends shall be ground smooth. All dust and debris must be fully removed. Ends shall be resin-coated to prevent corrosion, in pipe 24" Diameter and above an interior corrosion wrap is required. The joint should be of equal strength as the pipe. A butt and wrap sequence and thickness chart should be shown on the fabrication drawings. The laminate sequence for each size duct should be supported by a separate section in the design calculations.

B. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with the requirements in the Section titled "Pipe Supports". Where necessary to avoid stress on equipment or structural members, the pipes shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

3.4 INSPECTION AND FIELD TESTING

A. Inspection: All finished installations shall be carefully inspected for proper joints and sufficient supports, anchoring, interference, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.

B. Field Testing: Prior to enclosure or buying, all piping systems shall be pressure tested at 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials and devices at no extra cost to the Owner.
   1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be

connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

2. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re- tested until no leaks are found.

END OF SECTION 233100

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Double-wall round and flat-oval ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.

B. Related Sections:

1. Division 22 and 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
2. Division 22 and 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.

1. Static-Pressure Classes:

a. Supply Ducts (except in Mechanical Rooms): 2-inch wg.
b. Supply Ducts (Upstream from Air Terminal Units): 3-inch wg.
c. Supply Ducts (Downstream from Air Terminal Units): 1-inch wg.
d. Supply Ducts (in Mechanical Equipment Rooms): 2-inch wg.
e. Return Ducts (Negative Pressure): 1-inch wg.
f. Exhaust Ducts (Negative Pressure): 1-inch wg.

2. Leakage Class:

a. Round Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.

b. Flat-Oval Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
c. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
d. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular

Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Lindab Inc.
    b. McGill AirFlow LLC.
    c. SEMCO Incorporated.
    d. Sheet Metal Connectors, Inc.
    e. Spiral Manufacturing Co., Inc.
    f. Metco.
    g. Prior approved equal.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.
e. Prior approved equal.
f. Maximum Thermal Conductivity:

1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating.

Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

3. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

4. Duct insulation shall have a minimum R value = 5 for installation in an unconditioned space, and a minimum R value = 8 for installation outdoors.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 22 Section "Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

1. For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C, except as follows:

a. Ducts that are located directly in zones they serve.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 22 and 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
2. Test the following systems:

    a. Supply air.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before insulation application.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 22 and 23 Section "Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel:

B. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless-Steel Ducts: Galvanized steel.
3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

C. Liner:

1. Supply- and Return-Air Ducts: Fibrous glass, Type I.

D. Double-Wall Duct Interstitial Insulation:

1. Supply- and Return-Air Ducts: 1 inch thick.

E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

        1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
        2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
        3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

    b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
    c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

    a. Rectangular Main to Rectangular Branch: 45-degree entry.
    b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

    a. Velocity 1000 fpm or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm: Conical tap.
    c. Velocity 1500 fpm or Higher: 45-degree lateral.

G. Duct Schedule

1. Rectangular duct with liner:

    a. Low pressure supply and return.

2. Rectangular duct wrapped with insulation:

    a. Low pressure exhaust and fresh air.

3. Single wall round with wrapped insulation.

    a. Low pressure supply and return.

END OF SECTION 233113

SECTION 233300 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Volume dampers.
   2. High Efficiency Take-Offs.
   3. Turning vanes.
   4. Flexible connectors.
   5. Flexible ducts.
   6. Duct accessory hardware.

B. Related Sections include the following:

   1. Division 22 and 23 Section "HVAC Instrumentation and Controls" for electric and pneumatic damper actuators.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Volume dampers.
   2. High Efficiency Take-Offs.
   3. Turning vanes.
   4. Flexible connectors.
   5. Flexible ducts.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Clifco
4. Flexmaster U.S.A., Inc.
5. Leader
6. McGill AirFlow Corporation.
7. METALAIRE, Inc.
8. Nailor Industries Inc.
9. Penn Ventilation Company, Inc.
10. Ruskin Company.
11. Vent Products Company, Inc.
12. Air Rite.
13. Greenheck.
14. Prior approved equal.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Standard Volume Dampers: Opposed-blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel.
7. Bearings: Oil-impregnated bronze.
8. Tie Bars and Brackets: Aluminum.
9. Tie Bars and Brackets: Galvanized steel.

D. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 HIGH EFFICIENCY TAKE-OFF

A. Factory-manufactured rectangular-to-round or round-to-round 45 degree leading tap fabricated of 24 ga zinc-coated lockforming quality steel sheets meeting requirements of ASTM A 653, with G-90 coating.

B. One inch wide mounting flange with die formed corner clips, pre-punched mounting holes, and adhesive coated gasket.

C. Manual Volume Damper:

1. Single blade, 22 ga minimum.
2. 3/8 inch minimum square rod with brass damper bearings at each end.
3. Heavy duty locking quadrant on 1-1/2 inch high stand-off mounting bracket attached to side of round duct.

D. Approved Manufacturers:

1. HETD-L by Daniel Manufacturing.
2. STO by Flexmaster USA Inc.
3. HET by Sheet Metal Connectors Inc.

4. Hercules.
5. Clifco
6. Air-Rite.
7. Prior approved equal.

2.5 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Available Manufacturers:

a. Ductmate Industries, Inc.
b. Duro Dyne Corp.
c. METALAIRE, Inc.
d. Ward Industries, Inc.
e. Prior approved equal.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.6 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Flex-Weld
4. Ventfabrics, Inc.
5. Ward Industries, Inc.
6. Prior approved equal.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.7 FLEXIBLE DUCTS

A. Manufacturers:

1. Flexmaster U.S.A., Inc.
2. Hart & Cooley, Inc.
3. McGill AirFlow Corporation.
4. Themaflex.
5. Quietflex
6. Prior approved equal.

B. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

H. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

I. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

J. Connect diffusers to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

K. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 22 and 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233300

SECTION 233313 – DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes dampers for the following systems:

1. Backdraft Damper

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

1.3 SUBMITTALS

A. Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.

B. Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

C. Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.4 ADDITIONAL SUBMITTAL INFORMATION

A. The Contractor shall submit a copy of this specification with check-marks by each line to show full compliance or a note with attached supporting information noting any deviation for Engineer review.

B. A letter from the resin supplier stating that the material used for this project complies with the specification and meet all corrosion requirements.

C. Design calculations performed by the manufacturer and stamped by a Professional Engineer for record purposes.

D. Duct manufacturer shall submit certified test results in accordance with ASTM 2992. Engineer will confirm that supplier has completed ASTM 2992 testing.

E. Samples shall be representative of the ductwork (construction method and material used) to be

supplied on this project

1.5 REFERENCES

A. Codes and Standards

1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
3. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers".
4. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.
5. ASTM D 3567: Practice for Determining Dimensions of Fiberglass Pipe and Fittings.
6. ASTM C 582: Standard Specification for Contact – Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion – Resistant Equipment
7. AWWA M-45: American Water Works Manual of Water Supply Practices “Fiberglass Pipe Design.”
8. ASTM D 3982: Standard Specification for Contact Molded “Fiberglass” Duct and Hoods or NBS PS 15-69 “Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment.”
9. ASTM D 2992: “Standard Practice for Obtaining Hydrostatic Design Basis for Fiberglass Pipe and Fittings.”
10. ASTM D 2310: “Standard Classification for Machine-Made Fiberglass Pipe.”

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection

1. Protect shop-fabricated and factory-fabricated accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage

1. Where possible, store accessories inside and protect from weather. Where necessary to store outside, store above grade and enclosed with waterproof wrapping.

PART 2 - PRODUCTS

A. BACKDRAFT DAMPER

1. High performance gravity operated backdraft damper for use in medium to heavy duty commercial and light industrial HVAC applications.

2. Damper shall be corrosion resistant extruded aluminum construction, including a reinforced mitered corner frame that resists racking and aerodynamic blades that overlap

the jambs for maximum weather protection. Extruded PVC blade seals shall be provided to provide quite closure as well as extra weather protection. Blade linkage shall be mounted out of view on the rear of the blades and shall provide smooth operation at system velocities of up to 2,500 fpm.

3. Standard Construction:
   a. Frame: 2 ¼" duct mount type, 0.125" nominal wall thickness type 6063-T5 extruded aluminum. Corners shall be mitered
   b. Blades: 0.070" nominal wall thickness type 6063-T5 extruded aluminum on 5 ½" centers.
   c. Linkage: Center mounted on rear of blades
   d. Bearings: Synthetic type.
   e. Blade Seals: Extruded PVC
   f. Finish: Mill
   g. Maximum Temperature: 200F
   h. Maximum Backpressure: 4 to 16 in w.g.
   i. Maximum System Velocity: 2,500 fpm.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

3.3 FIELD QUALITY CONTROL

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak-proof performance.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust ductwork accessories for proper settings.

   1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 233423 – EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Centrifugal roof ventilators.
2. Inline Exhaust Fan.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Loren Cook Company ACE-B or equal by
2. Acme Engineering & Mfg. Corp.
3. Aerovent; a Twin City Fan Company
4. American Coolair Corp.
5. Carnes Company HVAC.
6. Greenheck.
7. JencoFan; Div. of Breidert Air Products.
8. Penn Ventilation.
9. Twin City
10. Prior approved equal.

B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Spring loaded, automatic belt tensioning pulley.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in cant and mounting flange.
2. Overall Height: 12 inches.
3. Sound Curb: Curb with sound-absorbing insulation matrix.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Mounting Pedestal: Galvanized steel with removable access panel.
7. Vented Curb: Unlined with louvered vents in vertical sides.

H. Capacities and Characteristics: See drawings.

2.2 INLINE EXHAUST FAN

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Loren Cook Company. Gemini or equal by.
2. American Coolair Corp.
3. Carnes Company HVAC.
4. Greenheck.
5. JencoFan; Div. of Breidert Air Products.
6. NuTone Inc.
7. Penn Ventilation.
8. Twin City
9. Prior approved equal.

B. Description: Centrifugal fans designed for installing in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:

1. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
3. Motion Sensor: Motion detector with adjustable shutoff timer.
4. Manufacturer's standard roof jack or wall cap, and transition fittings.

G. Capacities and Characteristics: See drawings.

2.3 MOTORS

A. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops Insert device having a static deflection of 1 inch. Vibration-control devices are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Division 22 and 23 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 22 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes ceiling-diffusers and wall-mounted registers and grilles.

B. Related Sections include the following:

1. Division 22 and 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 GRILLES AND REGISTERS

A. Adjustable Bar Side Wall Supply Grille:

1. Products:

a. Carnes; RVEA.
b. Krueger; 5815.

c. METALAIRE, Inc., Metal Industries Inc.; 422.
d. Price Industries; LBMR.
e. Titus; 1707.
f. Tuttle & Bailey; VF5.
g. Or equal by:

1) A-J Manufacturing Co., Inc.
2) Anemostat; a Mestek Company.
3) Dayus Register & Grille.
4) Hart & Cooley, Inc.; Hart & Cooley Div.
5) Nailor Industries of Texas Inc.

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Adjustable horizontal spaced 1/4 inch apart.
5. Frame: 1 inch wide.

B. Fixed Face Ceiling Return, Exhaust, or Transfer Air Grille:

1. Products:

a. Carnes; RSLA.
b. Krueger; S85H.
c. Price Industries; 535.
d. Titus; 355RL.
e. Tuttle & Bailey; T70D.
f. Or equal by:

1) A-J Manufacturing Co., Inc.
2) Anemostat; a Mestek Company.
3) Dayus Register & Grille.
4) Hart & Cooley, Inc.; Hart & Cooley Div.
5) Nailor Industries of Texas Inc.

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2 inch horizontal blade spacing.
5. Frame: 1-1/4 inches wide.

2.3 CEILING DIFFUSER OUTLETS

A. Rectangular and Square Ceiling Diffusers:

1. Products:
a. Carnes.
b. Krueger.
c. METALAIRE, Inc., Metal Industries Inc.
d. Price Industries; SPD or equal by.
e. Titus.
f. Tuttle & Bailey.
g. A-J Manufacturing Co., Inc.

h. Anemostat; a Mestek Company.
i. Hart & Cooley, Inc.; Hart & Cooley Div.
j. Nailor Industries of Texas Inc.
k. Prior approved equal.

2. Material: Steel.
3. Finish: Baked enamel, white.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, provide lay-in ceiling module. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233714 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fixed, extruded-aluminum louvers.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Vertical Louver: Louver with vertical blades; i.e., the axes of the blades are vertical.

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

E. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 PERFORMANCE REQUIREMENTS

A. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
   1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

2. Show mullion profiles and locations.
3. Wiring Diagrams: For power, signal, and control wiring for motorized adjustable louvers.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of metal finish required.

E. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

D. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.

D. Fasteners: Use types and sizes to suit unit installation conditions.
1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
4. For fastening stainless steel, use 300 series stainless-steel fasteners.
5. For color-finished louvers, use fasteners with heads that match color of louvers.

E. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Include supports, anchorages, and accessories required for complete assembly.

C. Provide subsills made of same material as louvers or extended sills for recessed louvers.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Nondrainable-Blade Louver:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ruskin Company; Tomkins PLC. Model ELF811 or equa by.
   b. Airolite Company, LLC (The).
   c. American Warming and Ventilating, Inc.; a Mestek company.
   d. Arrow United Industries; a division of Mestek, Inc.
   e. Carnes Company, Inc.
   f. Cesco Products; a division of Mestek, Inc.
   g. Greenheck Fan Corporation.
   h. NCA Manufacturing, Inc.
   i. Pottrof
   j. United Enertec
   k. Prior approved equal.
2. Fabrication: Continuous blade style.
   a. Frame:
      1) Frame Depth: 4 inches (102mm).
      2) Material: Extruded aluminum, Alloy 6063-T5.
      3) Wall Thickness: 0.125 inch (3.2mm), nominal.
   b. Blades:
      1) Style: Horizontal “K”.
      2) Material: Formed aluminum, Alloy 6063-T5.
      3) Wall Thickness: 0.125 inch (3.2 mm), nominal.
      4) Angle: 45 degrees.

5) Centers: 4-1/2 inches (114 mm), nominal.
6) Continuous Blade Style – Design incorporates visible mullions or frames at the perimeter of the louver only. Rear-mounted hidden blade supports are utilized at section joints and at intermediate locations as needed. Louver blade sightlines are not interrupted at section joints or blade support locations. The rear-mounted blade support depth varies depending on louver height and the design windload.
7)

c. Assembly:
1) Factory assembled louver components. Mechanically fastened construction.

B. Performance Data:
1. Performance Ratings:
a. Based on testing 48 inch by 48 inch (1219 mm by 1219 mm) size unit in accordance with AMCA 500.
2. Free Area: 44 percent, nominal.
3. Maximum Recommended Air Flow through Free Area: 707 feet per minute (214 m/min).
4. Air Flow: 5027 cubic feet per minute (142 cu. m/min).
5. Maximum Pressure Drop (Intake): .06 inches w.g. (14.9 Pa).
6. Water Penetration: Maximum of 0.01 ounces per square foot (3.1 g/sm) of free area at an air flow of 707 feet per minute (214 m/min) free area velocity when tested for 15 minutes.

C. Design Load: Incorporate structural supports required to withstand wind load of:
1. 20 lb/sf (0.96 kPa).
2. Per Code.
3. Louvers shall be factory engineered to withstand the specified seismic loads.
a. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction.

2.4 ACCESSORIES

A. Aluminum Insulated Blank-Off Panels: 1 inch (25 mm), aluminum skin, insulated core, factory installed with removable screws and neoprene gaskets.

B. Hinged Frame: Continuous piano hinge attached to angle subframe.

C. Hinged Frame: Continuous piano hinge attached to channel subframe.

D. Bird Screen:
1. Aluminum: Aluminum, 3/4 inch by 0.051 inch (19 mm by 1.3 mm), expanded, flattened.
2. Aluminum: Aluminum, 5/8 inch by 0.040 inch (16 mm by 1 mm), expanded, flattened.
3. Aluminum: Aluminum, 1/2 inch mesh by 0.063 inch (13 mm mesh by 1.6 mm), intercrimp.
4. Steel: Galvanized steel, 1/2 inch mesh by 19 gage (13 mm mesh by 1.1 mm), intercrimp.

5. Frame: Removable, rewireable.

2.5 FINISHES

A. Kynar:
   1. Coating shall conform to AAMA 2605. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
   2. Standard 2-coat.
   3. Pearledize 70 (2-coat mica).

B. 50 percent Floropolymer-Based Painted Finishes:
   1. Coating shall conform to AAMA 2604, sections 4.2 and 4.3. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
   2. Baked Enamel.
   3. Pearledize 50 (2-coat mica).

C. Color for Kynar Finish:
   1. Color: Custom. Refer to Drawings.

D. Anodized Finishes:
   1. Class 2 Clear Anodized.
      a. Comply with Aluminum Association AA-C22A41. Clear anodized finish 215-R1.
      b. Apply finish following chemical etching and pretreatment.
      c. Minimum Thickness: 0.7 mils (0.018 mm), 60 minute anodizing process.
   2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 233714

SECTION 235200 – WATER BOILER

PART 1 GENERAL

1.1 SUMMARY

A. This section includes packaged, factory-fabricated and assembled, three pass firetube boilers, trim, and accessories for hydronic heating applications (30 psi design standard). Consult factory for higher design pressures of 40, 80 and 150 psi.

Refer to Section 2.2 "Forced Draft Burner" and select burner fuel type(s) and mode of operation.

1. Horizontal three pass firetube boiler

Two pass boiler construction is not acceptable.

a. SUBMITTALS

1.2 A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories; Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Fuel Train Schematic

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

1.4 B. Warranties: As specified in this section.

QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Section IV Boiler and Pressure Vessel Code.

C. ASHRAE/IESA 90.1 Compliance: Boilers shall have minimum efficiency according to: Gas and Oil-Fired Boilers – Minimum Efficiency Requirements."

D. UL Compliance: Control devises and control sequences according to requirements of UL.

E. CSD-1 Compliance: Boilers/burners equipped to meet current state code.

F. The boiler must be manufactured by a company having at least ten (10) years documented boiler manufacturing experience in accordance to ASME Section IV Boiler and Pressure Vessel Code.

COORDINATION

A. Furnish and coordinate size and location of concrete bases.

WARRANTY

1.5

A. Special Warranty: Manufacturer's standard form in which manufacturer warrants the Boiler Pressure Vessel for five (5) years pro-rated after date of shipment with the first two (2) years non-pro-

1.6 rated. This warranty is to cover tube leaks and other possible damages to boiler tubes, tube sheets, furnace, and main shell due to thermal shock expansion stresses ("shock"). In addition to the above pressure vessel warranty the burner, trim, and controls are warranted for a period of one (1) year after installation.

PRODUCTS

PART 2

HORIZONTAL THREE PASS FIRETUBE BOILER

2.1

A. Basis of Design Product: Subject to compliance with requirements, provide products as listed:

1. Aldrich Company – Manufactured in Wyoming, IL, Model: A3W4-60-G

B. Description: Factory packaged and firetested firetube boiler complete with gas burner, gas train, and controls mounted and wired, skid mounted requiring only supply, return, fuel, blowdown, electrical and vent connections.

C. Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist boiler movement during a seismic event when boiler base is anchored to building structure.

D. Design: Modified Scotch design "Scotch Box" with straight steel tubes with a minimum wall thickness of .105".

Three passes with wet-back design. Boilers not of the wetback design are not allowed. Include the following:

1. Handholes or inspection tappings for water-side inspection.
2. Lifting lugs on to of boiler.
3. Minimum 1" drain valve
4. Tappings or flanges for supply and return connections

E. U-Type Flex Joint: The furnace must incorporate a "U-Type" flex joint. The "U-Type" flex joint burner port to furnace minimizes the effects of differential stress as the boiler furnace expands at a greater rate than the firetubes during operation. Boilers with other types of furnace to front tube sheet construction are not allowed. Boiler designs with furnaces that extend through the front tube sheet are not acceptable.

F. Front and Rear Smokeboxes: Sealed with heat-resistant gaskets and fastened with lugs and cap screws and designed so tubes and flues are fully accessible for inspection or cleaning when doors are open.

G. Rear Access Door: Constructed with ceramic fiber insulation in door construction.

H. Boiler Casing: The external surfaces shall be covered with a minimum of 1" mineral fiber insulation encased within an 18-gauge steel jacket.

FORCED DRAFT BURNER

A. Basis of Design Product: Subject to compliance with requirements, provide products as listed:

1. Power Flame, Model: C3-GG-20

2.2

B. Code Compliance: UL, CSD-1

C. Available Fuels:

Select from the following: Natural gas and digester gas.

D. Mode of Operation:

Select from the following: Full Modulation

E. Burner must be factory mounted and wired including control panel.

F. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor.

G. Gas Train: Control devices shall comply with requirements in ASME CSD-1 and UL. Gas train to include pilot shut-off valve, regulator, pilot solenoid valve, intermittent electric spark pilot ignition with 100 percent main valve and pilot safety shutoff with electronic ultraviolet supervision of burner flame (flame rod not acceptable).

H. Main Gas Train: Factory piped and wired (may be removed for shipment as a complete assembly for protection), main gas regulator, motorized main gas safety shut off valve, secondary solenoid gas safety shut off valve, isolation valve(s) with test cock(s), high and low gas pressure switches. Digester gas train must be made of high-quality stainless steel.

2.3

WATER BOILER TRIM

A. Boiler to include the following trim factory mounted/wired:

1. The altimeter gauge
2. ASME relief valve
3. Operating aquastat
4. High limit aquastat (Manual Reset)
5. Firing rate control to match mode of operation
6. M&M #751P-MT Probe type low water cut-off (Manual Reset)
7. Stack Damper: Flue stack damper (Manual type)

SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping according to ASME Boiler and Pressure Vessel Code.

2.4

EXECUTION

PART 3

EXAMINATION

3.1

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Boiler locations on drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections and consult mechanical engineering Project Manager for approval prior to proceeding.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

3.2 C. Proceed with installation only after unsatisfactory conditions have been corrected.

BOILER INSTALLATION

A. Equipment Mounting: Install boilers on cast-in-place concrete equipment bases.

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct bases to withstand, without damage to equipment, seismic force as required by code.
3. Construct concrete bases 4” high and extend base not less than 6” in all directions beyond the maximum dimensions of boiler unless otherwise indicated.

B. Install gas-fired boilers according to NFPA-54.

C. Install electrical devices furnished with boiler but not specified to be factory mounted.

D. Refer to drawings for additional requirements.

START-UP SERVICE

A. The mechanical contractor is required to engage a factory authorized service representative to perform start-up services and provide owner's maintenance personnel training on the adjustment, operation, and recommended maintenance of the boilers.

3.3

END OF SECTION 235200

SECTION 235523.13 - LOW-INTENSITY, GAS-FIRED, RADIANT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes low-intensity, gas-fired, forced-draft radiant heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired, radiant heaters to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of radiant heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Period: All warranty periods listed below are from date of Substantial Completion.
   a. Burner Assembly: Three years.
   b. Combustion and Emitter Tubes: Two years.
   c. Heater Controls: One year(s).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. CSA certified, with CSA Seal and certification number clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

B. UL listed and labeled, with UL label clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FORCED-DRAFT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ambirad.
2. Detroit Radiant Products Company.
3. Roberts-Gordon, Inc.
4. Schwank Inc.
5. Space-Ray; a division of Gas-Fired Products Inc.
6. Sterling HVAC Products; a Mestek company.
7. Superior Radiant Products Ltd.
8. Prior approved equal.

B. Description: Factory-assembled, indoor , overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.

C. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

D. Burner Assembly:

1. Combustion-Air Inlet: Non-ducted, unvented.
2. Burner Control Housing: Stainless steel .
   a. Totally enclosed with stainless-steel access cover.
   b. Sight glass for visual inspection of burner.
   c. Finish: Enameled finish or powder-coated finish.
3. Burner: Stainless steel .
4. Ignition System: Silicon carbide hot-surface igniter with flame rod sensing capabilities and self-diagnostic control module.
5. Combustion Blower Fan: Dynamically balanced, direct-driven, forward-curved fan with cast-aluminum-alloy impeller and aluminized-steel housing, with a minimum temperature rating of 450 deg F.
6. Motors: General requirements for motors are specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

a. Motor: Resilient-mounted, capacitor-start-capacitor-run type with sealed ball bearings; totally enclosed, nonventilated type with internal thermal protection.
b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

E. Combustion Chamber: 4-inch-diameter, 12 -gage, aluminized -steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Chambers shall be equipped with sight glass for burner and pilot flame observation.

F. Emitter Tube: 4-inch-diameter, 12 -gage, aluminized -steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Emitter tubing shall be equipped with baffles to maximize heating efficiency.

1. Tubing Connections: Stainless-steel threaded couplings .
2. 90 -degree-bend emitter steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.
3. Exhaust Vent Termination: Vertical through roof with vent caps.

G. Reflector: Polished aluminum , with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors or entire heater shall accommodate rotational adjustment from horizontal to a minimum 30-degree tilt from vertical.

H. Accessories:

1. Reflector Extension Shields: Same material as reflectors, arranged for fixed connection to lower reflector lip and rigid support to provide 100 percent cutoff of direct radiation from tubing at angles greater than 30 degrees from vertical.
2. Protective grilles mounted to reflectors to protect emitter tubing.
3. Stainless-steel flexible connector with manual valve for gas supply.
4. Hanger chain with "S" hooks.
5. 3/16-inch-diameter, galvanized -steel wire tubing hangers and reflector supports.
6. Rigid mounting kits.
7. Clearance warning plaque.

2.3 CONTROLS AND SAFETIES

A. Gas Control Valve: Two-stage, regulated redundant 24-V ac gas valve that contains pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

B. Failure Safeguards: 100 percent shutoff of gas flow in the event of flame or power failure.

C. Prepurge of 15 seconds of air control system prior to burner ignition.

D. Safety lockout of burner after three consecutive ignition failures .

E. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.

F. Control Panel Interlock: Stops burner if panel is open.

G. Indicator Lights: "Airflow-on" and "burner-on" indicator lights.

H. Thermostat: Single-stage, wall-mounted type with 50 to 90 deg F operating range and fan on switch.

1. Control Transformer: Integrally mounted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine structures, substrates, areas and conditions, with Installer present, for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance of the Work.

B. Examine roughing-in for fuel-gas piping to verify actual locations of piping connections before equipment installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems according to NFPA 54 .

B. Suspended Units: Suspend from substrate using chain hanger kits and building attachments .

1. Restrain the unit to resist seismic acceleration. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

C. Maintain manufacturers' recommended clearances for combustibles.

3.3 CONNECTIONS

A. Gas Piping: Comply with Section 23 11 23 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

1. Gas Connections: Connect gas piping to radiant heaters according to NFPA 54 .

B. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.

C. Vent Connections: Comply with Section 23 31 13 "Metal Ducts" and with Section 23 51 23"Gas Vents."

D. Electrical Connections: Comply with applicable requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial-temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired, radiant heaters.

END OF SECTION 23 55 23.13

SECTION 235533 - FUEL-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes gas-fired unit heaters.

1.3 SUBMITTALS

A. Product Data: For each type of fuel-fired unit heater indicated. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: For fuel-fired unit heaters. Include plans, elevations, sections, details, and attachments to other work.

1. Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of fuel-fired unit heaters, as well as procedures and diagrams.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which equipment will be attached.
2. Items penetrating roof and the following:

    a. Vent and gas piping rough-ins and connections.

D. Manufacturer Seismic Qualification Certification: Submit certification that fuel-fired unit heaters, accessories, and components will withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For fuel-fired unit heaters to include in operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchanger of fuel-fired unit heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One for each belt-driven fan size.

PART 2 - PRODUCTS

2.1 GAS-FIRED UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lennox Industries, Inc.
2. Modine Manufacturing Company.
3. Reznor/Thomas & Betts Corporation.
4. Sterling HVAC Products; Div. of Mestek Technology Inc.
5. Trane
6. Prior approved equal.

B. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.

C. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

D. Type of Venting: Indoor, separated combustion, power vented.

E. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.

1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.
2. Suspension Attachments: Reinforce suspension attachments at connection to fuel-fired unit heaters.

a. Seismic Fabrication Requirements: Fabricate suspension attachments of fuel-fired unit heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls" when fuel-fired unit heater is anchored to building structure.

F. Heat Exchanger: Aluminized steel.

G. Burner Material: Aluminized steel with stainless-steel inserts.

H. Unit Fan: Formed-steel propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.

1. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
2. General requirements for motors are specified in Division 22 and 23 Section "Motors."

a. Motors: Totally enclosed with internal thermal-overload protection and complying with Division 22 and 23 Section "Motors."
b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

I. Unit Fan: Steel, centrifugal fan dynamically balanced and resiliently mounted.

1. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
c. Pulleys: Cast-iron, adjustable-pitch motor pulley.

2. General requirements for motors are specified in Division 22 and 23 Section "Motors."

a. Motors: Totally enclosed with internal thermal-overload protection and complying with Division 22 and 23 Section "Motors."
b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
c. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

J. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

1. Gas Control Valve: Modulating.
2. Ignition: Electronically controlled electric spark with flame sensor.
3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
4. Vent Flow Verification: Differential pressure switch to verify open vent.
5. Control transformer.
6. High Limit: Thermal switch or fuse to stop burner.
7. Thermostats: Devices and wiring are specified in Division 22 and 23 Section "HVAC Instrumentation and Controls."
8. Thermostat: Single-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.
9. Thermostat: 2-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.
10. Thermostat: Single-stage type with duct-mounting sensor and 50 to 90 deg F operating range.
11. Thermostat: 2-stage type with duct-mounting sensor and 50 to 90 deg F operating range.

K. Discharge Louvers: Independently adjustable horizontal blades.

L. Accessories:

1. Vertical discharge louvers.
2. Discharge Nozzle: Discharge at 25 to 65 degrees from horizontal.
3. Four-point suspension kit.
4. Summer fan switch.
5. Unit-mounted thermostat bracket.
6. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.

7. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

B. Install and connect oil-fired unit heaters and associated fuel and vent piping according to NFPA 31, applicable local codes and regulations, and manufacturer's written installation instructions.

C. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

1. Restrain the unit to resist code-required horizontal acceleration.

D. Substrate-Mounted Units: Provide supports connected to substrate. Secure units to supports.

1. Spring hangers and seismic restraints are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."
2. Anchor the unit to resist code-required horizontal acceleration.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.

C. Gas Piping: Comply with Division 22 and 23 Section "Fuel Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Fuel Oil Piping: Comply Division 22 and 23 Section "Fuel Oil Piping." Connect to fuel oil supply and return piping with shutoff valve and union at each connection.

E. Vent Connections: Comply with Division 22 and 23 Section "Breechings, Chimneys, and Stacks."

F. Electrical Connections: Comply with applicable requirements in Division 22 and 23 Sections.

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

a. Test procedures used.
b. Test results that comply with requirements.
c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-fired unit heaters. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 235533

SECTION 237200 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Packaged energy recovery units.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Air-to-air energy recovery equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.

   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For air-to-air energy recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

   1. Detail fabrication and assembly of air-to-air energy recovery equipment.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

D. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment or suspension systems will be attached.

E. Seismic Qualification Certificates: For air-to-air energy recovery equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Field quality-control reports.

G. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ARI Compliance: Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Rating Air-to-Air Energy Recovery Equipment."

C. ASHRAE Compliance: Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance: Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."

1.6 COORDINATION

A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Packaged Energy Recovery Units: Two years.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: provide 3 sets, one for construction, one for occupancy, and one for change out post occupancy.
2. Fan Belts: One set(s) of belts for each belt-driven fan in energy recovery units.
3. Wheel Belts: One set(s) of belts for each heat wheel.

PART 2 - PRODUCTS

2.1 PACKAGED ENERGY RECOVERY UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Valent or equal by
2. Greenheck Fan Corporation.
3. Loren Cook Company.
4. RenewAire LLC.
5. Swegon
6. Venmar CES Inc.
7. Prior approved equal

B. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed and calked weathertight, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.

1. Inlet: Weatherproof hood, with gravity backdraft damper for exhaust and spring-return, two-position, motor-operated damper with blade seals for supply.
2. Roof Curb: Refer to Division 7 Section "Roof Accessories" for roof curbs and equipment supports.

C. Heat Recovery Device: Heat wheel.

D. Supply and Exhaust Fans: Forward-curved, centrifugal fan with spring isolators and insulated flexible duct connections.

1. Motor and Drive: Direct driven.
2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 and 23 Section "Common Motor Requirements for HVAC Equipment."
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
5. Spring isolators on each fan having 1-inch static deflection.

E. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
4. Factory-fabricated, viscous-coated, flat-panel type.
5. Thickness: 2 inches pre-filter.
6. Merv (ASHRAE 52.2): 13 post filter.
7. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
8. Frame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

F. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.

1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
2. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
3. Include fused disconnect switches.
4. Variable-speed controller to vary fan capacity from 100 to approximately 50 percent.

G. Accessories:

1. Roof Curb: Galvanized steel with gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 24 inches.
2. Intake weather hood with 2-inch-thick filters.
3. Louvered intake weather hood with 2-inch-thick filters in V-bank configuration.

4. Exhaust weather hood with birdscreen.
5. Low-Leakage, Isolation Dampers: Double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed-blade arrangement with cadmium-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single frame, with operating rods connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.
6. Duct flanges.
7. Rubber-in-shear isolators for ceiling-mounted units.
8. Hinged access doors with quarter-turn latches.
9. Drain pans for condensate removal.
10. Automatic, in-place, spray-wash system.
11. Weatherproofing for tilt-control system.
12. Electric heater section

2.2 CONTROLS

A. Time Clock: Solid-state, programmable, microprocessor-based unit for mounting in outdoor NEMA 250, Type 3R enclosure with up to eight on/off cycles per day and battery backup protection of program settings against power failure to energize unit.

2.3 CAPACITIES AND CHARACTERISTICS – See drawings

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.

1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.

2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
3. Access doors and panels are specified in Division 22 and 23 Section "Duct Accessories."

B. Roof Curb: Install on roof structure or concrete base, level and secure, according to ARI Guideline B. Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 7 Section "Roof Accessories." Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

C. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure air-to-air energy recovery equipment to structural support with anchor bolts.

D. Install wind and seismic restraints according to manufacturers' written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 22 and 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Install units with clearances for service and maintenance.

F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

G. Pipe drains from units and drain pans to nearest floor drain; use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints or ASTM D 1785, Schedule 40 PVC pipe and solvent-welded fittings, same size as condensate drain connection.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 and 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for ductwork specified in Division 22 and 23 Section "Metal Ducts."

C. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 237200

SECTION 237400 - PACKAGED CONDENSER UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged roof-top air conditioner, split system with air cooled condensing unit and fan coil unit, packaged room air conditioner, piping, insulation and accessories.

B. Related Requirements:

1. Section 230593 “Test, Adjust, and Balance of Air Systems”.
2. Section 013300 “Contractor Submittals”.

1.2 SUBMITTALS

A. Submit in accordance with Section 013300 “Contractor Submittals”.

B. Product Data: Submit manufacturer’s product data and installation procedures for each type of product specified in this section.

C. Shop Drawings: Shall be for entire air conditioning system. Provide coordinated layout drawings minimum 1/4" per foot, which show all piping, sprinkler heads, ductwork, equipment, conduit, cable trays, pull boxes, light fixtures, access panels, architectural, and structural systems. All trades to coordinate in preparation of drawings to establish final locations of work. Areas of extreme congestion shall be shown at 1/2" scale.

PART 2 - PRODUCTS

2.1 SPLIT AC SYSTEM WITH VARIABLE REFRIGERANT FLOW

A. General: Split system consists of outdoor air-cooled condensing unit and indoor fan coil unit using R410A refrigerant. ETL listed. Factory charged and tested. Outdoor Condensing Unit and indoor fan coil shall be Carrier, American Standard, Daikin, Mitsubishi or approved equivalent:

1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigerant circuit of the condensing unit shall consist of single or multiple scroll compressors on isolation mounts with inverter driven variable speed drive, propeller fan, condenser coil, expansion valve, solenoid valves, 4 way valve, filters, shut off valves, service ports, liquid receivers and accumulators. Refrigerant shall be R-410A.
2. Safety devices to be included on the condensing unit are high pressure switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
3. The outdoor unit shall be completely weather proof and corrosion resistant. The unit shall be

constructed from galvanized steel panel with acrylic or polyester powder coating and baked enamel finish. Provide locally applied corrosion protection coating on the casing.

4. The condensing unit fan motor shall have multiple speed operation of the DC inverter type.
5. The coils shall have locally applied corrosion treatment.

C. Indoor Fan Coil Unit:

1. Indoor unit shall be of the type as shown on plans and equipped with an electronic expansion valve and PID control to maintain room temperature.

2. Unit cabinet shall have MERV 8 filter and drain pan with condensate pump as required.

3. Unit shall be provided with a separate power supply.

4. Unit shall have wall mount controller and remote sensor as required to perform input functions necessary to operate the system.

5. Factory designed piping joints and headers.

6. Provide locally applied corrosion protection coating on the evaporator coil on units with more than 50% outside.

2.2 REFRIGERANT AND CONDENSATE PIPING

A. Refrigerant piping shall be Type ACR, ASTM B 280 copper tubing with wrought copper fittings and brazed joint.

B. Condensate piping shall be Type L, ASTM B 88 hard drawn copper tubing or DWV copper, ASTM B 306 with wrought copper fittings, silver solder joint or PVC, ASTM D 1785, solvent joint.

C. Refer to Section 237000 “Mechanical Insulation”, for refrigerant and condensate piping insulation

PART 3 - EXECUTION

3.1 ACCESS

A. Coordination: Install equipment with associated piping to permit access to doors and service areas as required for ease of maintenance.

3.2 CAPACITIES

A. Substitutions: Scheduled capacities reflect calculations based on manufacturer' recommended procedures using listed accessories and design parameters. Insure that substitute equipment will provide similar operating characteristics and capacities.

3.3 INSTALLATION

A. Coordination: Install equipment in accordance with manufacturer's recommendations. Bring conflicts between such recommendations and drawings to immediate attention of Architect/Engineer.

B. Isolation Valves: Provide isolation valves on all equipment.

C. Refrigerant piping:

1. Install the pipe sizes as indicated on the plans. Pitch all refrigerant lines in the direction of refrigerant flow; 1/2-inch in 10 feet. Furnish and install all refrigerant piping in accordance with good industry practice. Verify that all piping sizes are in accordance with factory recommendations. Submit recommended pipe size changes to engineer before installation.
2. Install piping so as not to interfere with access to unit.
3. Pass dry nitrogen through piping system during brazing process to totally eliminate formation of copper oxides.

3.4 START-UP AND TESTING

A. Requirements: Performed by factory authorized personnel at completion of project. Test and adjust to conform to project requirements. Submit written report to Engineer.

END OF SECTION

SECTION 237413 – PACKAGED OUTDOOR, CENTRAL-STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes cooling and heating packaged rooftop units.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:

1. Design Calculations: For selecting and designing restrained vibration isolation roof-curb rails.
2. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wiring Diagrams: Power, signal, and control wiring.

C. Startup service reports.

D. Operation and Maintenance Data: For rooftop units to include in operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Units shall be designed to operate with HCFC-free refrigerants.

1.6 COORDINATION

A. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

B. Coordinate size, location, and installation of rooftop unit manufacturer's roof curbs and equipment supports with roof Installer.

1. Coordinate installation of restrained vibration isolation roof-curb rails, which are specified in Division 22 and 23 Section "Mechanical Vibration and Seismic Controls."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON, Inc.
2. Carrier.
3. Daikin
4. Trane.
5. York.
6. Prior approved equal.

2.2 CABINET

A. Construction: Single wall.

B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.

C. Interior Casing: Galvanized steel.

D. Base Rails: Galvanized-steel rails for mounting on roof curb.

E. Service Doors: Hinged access doors with neoprene gaskets.

F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.

1. Thickness: 1 inch.
2. Insulation Adhesive: Comply with ASTM C 916, Type I.
3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

G. Condensate Drain Pans: Formed sections of galvanized-steel sheet designed for self-drainage. Fabricate pans with slopes to preclude buildup of microbial slime.

H. Provide with auxiliary hail guards to protect the condenser fins from storm damage.

2.3 SUPPLY-AIR FAN

A. Fan: Forward-curved centrifugal; statically and dynamically balanced, galvanized steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings.

B. Motor: Open dripproof, single-speed motor.

C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.

D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with elastomeric isolators.

2.4 REFRIGERATION SYSTEM

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Compressors: Scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.

C. EER and COP: as defined by ASHRAE/IESNA 90.1-2019, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Refrigerant: R-410A.

E. Refrigeration System Specialties:

1. Expansion valve with replaceable thermostatic element.
2. Refrigerant dryer.
3. High-pressure switch.
4. Low-pressure switch.
5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
6. Brass service valves installed in discharge and liquid lines.
7. Operating charge of refrigerant.

F. Refrigerant Coils: Evaporator and condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.

1. Capacity Reduction: Circuit coils for interleaved control.
2. Tubes: Copper.
3. Fins: Aluminum.
4. Fin and Tube Joint: Mechanical bond.
5. Suction and Distributor: Seamless copper tube with brazed joints.
6. Source Quality Control: Test to 450 psig, and to 300 psig underwater.

G. Condenser Fan: Propeller type, directly driven by motor.

H. Safety Controls:

1. Compressor motor and outside-coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor and outside-coil fan motors.

2.5 INDIRECT-FIRED GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."

1. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners: Aluminized steel with stainless-steel inserts with a minimum thermal efficiency of 80 percent.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark with flame sensor.
3. High-Altitude Kit: For Project elevations more than 2000 feet above sea level.

C. Heat-Exchanger Drain Pan: Stainless steel.

D. Venting: Gravity vented.

E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

F. Safety Controls:

1. Gas Control Valve: Two stage.
2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.6 OUTDOOR-AIR INTAKE AND DAMPERS

A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.

B. Damper Operators: Electric.

C. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.

D. Outdoor-Air Intake Hoods: Galvanized steel, with bird screen and finish to match cabinet.

2.7 ECONOMIZER:

A. Provide fully modulating damper motors and controls to position outside and return air dampers so that outside air will be used to satisfy the building cooling load in the economizer cycle and minimum outside air during occupied mode.

B. Low leakage dampers shall ride on nylon bearings.

C. Integrated economizer control shall allow compressors to cycle for additional cooling as needed based on outdoor enthalpy.

D. Damper actuators shall be opposing gear driven, 24 volt, fully modulating design. Plug-in control board shall consist of adjustable minimum positioner, enthalpy setpoint, and DIP switches for setting type of control logic use.

E. Outdoor air hood with filters shall be galvanized steel with a powder coat enamel paint finish electrostatically bonded to the metal.

F. For units 5 tons and under, provide extruded aluminum gravity relief dampers to prevent blow-back and outdoor air infiltration during off cycle.

G. For units over 5 tons, provide Centrifugal power exhaust fan which ever is standard for size of unit.

H. Provide rainhoods and birdscreens.

2.8 FILTERS

A. Comply with NFPA 90A.

B. Cleanable Filters: 2-inch- thick, cleanable metal mesh.

C. Disposable Panel Filters: 2-inch- thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.

1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
2. Frame: Galvanized steel.

2.9 CONTROLS

A. Control equipment and sequence of operation are specified in Division 22 and 23 Section "HVAC Instrumentation and Controls."

B. Factory-wire connection for controls' power supply.

C. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.

D. Unit Controls: Solid-state control board and components with field-adjustable control parameters.

E. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.

1. Timer: Seven-day electronic clock.
2. Electrically interlock kitchen hood fire-extinguishing system to de-energize unit when fire-extinguishing system discharges.

F. Unit-Mounted Status Panel:

1. Cooling/Off/Heating Controls: Control operational mode.
2. Damper Position: Indicates position of outdoor-air dampers in terms of percentage of outdoor air.
3. Status Lights:

    a. Filter dirty.
    b. Fan operating.

c. Cooling operating.
d. Heating operating.

G. Refrigeration System Controls:

1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.

H. Heating Controls:

1. Staged Burner Control: Two steps of control.

I. Damper Controls - Integrate with BMS:

1. Wall-mounting pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space served by rooftop unit at minimum 0.05-inch wg.

J. Integral Smoke Alarm: Smoke detector installed in supply and return air. For units 2000 cfm and larger.

K. DDC Temperature Control: Stand-alone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Division 15 Section "HVAC Instrumentation and Controls." Links shall include the following:

1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:

a. Room temperature.
b. Discharge air temperature.
c. Refrigeration system operating.
d. Furnace operating.
e. Constant and variable motor loads.
f. Monitor variable frequency drive operation.
g. Monitor cooling load.
h. Monitor economizer cycles.
i. Monitor air distribution static pressure and ventilation air volumes.

2.10 STANDARD FULL PERIMETER ROOF CURB

A. Provide unit manufacturer’s factory built curb that shall meet the National Roofing Contractors Association August 1985 guidelines for roof mounted installations.

B. The curb shall be 14 inches high, 16 gauge, galvanized steel construction with a 2 x 4 pressure treated wood nailer strip furnished on the outside.

C. Coordinate with drawings for locations requiring a roof curb, and locations requiring ground mounting on an exterior concrete pad.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation of rooftop units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where rooftop units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install roof curb on roof structure, according to ARI Guideline B. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing with roof construction.

B. Install restrained vibration isolation roof-curb rails on roof structure according to ARI Guideline B. Install and secure rooftop units on rails and coordinate roof penetrations and flashing with roof construction. Restrained isolation roof-curb rails are specified in Section "Mechanical Vibration and Seismic Controls."

C. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

1. Gas Burner Connections: Comply with requirements in Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.

C. Duct Connections: Duct installation requirements are specified in Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to rooftop units with flexible duct connectors. Flexible duct connectors are specified in Division 22 and 23 Section "Duct Accessories."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to furnace combustion chamber.
2. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
3. Inspect casing insulation for integrity, moisture content, and adhesion.
4. Verify that clearances have been provided for servicing.
5. Verify that controls are connected and operable.
6. Verify that filters are installed.
7. Clean outside coil and inspect for construction debris.
8. Clean furnace flue and inspect for construction debris.
9. Inspect operation of power vents.
10. Purge gas line.
11. Inspect and adjust vibration isolators and seismic restraints.
12. Verify bearing lubrication.
13. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
14. Adjust fan belts to proper alignment and tension.
15. Start unit.
16. Start refrigeration system when outdoor-air temperature is within normal operating limits.
17. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
18. Operate unit for run-in period.
19. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure flue-gas temperature at furnace discharge.
    d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

24. Verify operational sequence of controls.
25. Measure and record the following airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Outdoor-air intake volume.

26. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through outside coil or from outside coil to outdoor-air intake.

27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-limit heat exchanger.
    b. Alarms.

C. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

E. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop units. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 237413

SECTION 237533 - EVAPORATIVE COOLER

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install commercial grade evaporative cooler complete with 6-position selector switch.

B. Unit shall be factory assembled and shipped as a complete unit.

C. Unit shall be supplied complete with roof curb designed to match slope of roof (if applicable).

PART 2 - PRODUCTS

2.1 CASING

A. Evaporative Cooler

1. Unit shall be commercial grade heavy duty evaporative cooler, with down discharge, two-speed motor, belt drive, furnished complete with circulating pump, pump screen, filter pads, float valve with stainless steel seat, screwed in overflow pipe. CFM capacity of unit shall not be less than amount shown on schedule.
2. Blower wheels and all cabinet parts shall be fabricated from hot dipped galvanized steel. Cabinet shall have additional weather resistant baked enamel coating. The sump shall have a bituministic coating.
3. Blower wheels shall be balanced, and blower bearings shall be mounted in rubber cushions. Bearing shall be provided with oil cups.
4. Motor shall be of the continuous duty open drip-proof type and shall be mounted in the upper-most part of the cabinet for a minimum exposure to water. Motor shall be mounted so that the belt tension can be readily adjusted by a positive mechanical means. Unit shall be shipped completely assembled and shall be factory tested with motor installed and operated prior to shipment. Motor shall be two-speed.
5. Filter cartridges shall have integral water distributing trough constructed so as to be visible and adjustable from the outside after installation. Filter cartridges shall be removable on four sides of the unit. Filter cartridges louver openings shall be formed to deflect water to the inside. Filters shall be locked in place by a serrated bar integral with the water distributing trough.
6. Filter pads shall be made of equal parts white aspen fibers and redwood fibers, enclosed in mildew resistant cotton mesh. Mesh shall be nominal 3 X 3 per inch on the outside surface and nominal 16 X 20 per inch on the inside surface. Finished pads shall be securely closed on all edges and quilted for stability. Wood fibers mechanically compressed after shredding may not be used.

7. Contractor shall provide job built full perimeter curb with flashing and counter flashing into the roof. Curb shall fit slope of roof (if applicable).
8. Water piping to evaporative cooler shall be roughed up through the roof. Piping shall be sloped back down to the building water source so it can be centrally drained. Do not pipe in any water traps to prevent this draining. Flash and counter flash water pipes at roof. Provide shut-off valve on water line to evaporative cooler, as well as a union connection.
9. Overflow from evaporative cooler shall be piped to the roof so that removal of the screwed in stand pipe will drain all water from the sump.
10. All parts shall carry a minimum guarantee by the original manufacturer.

    a) 100 % hot dipped galvanized cabinet, blower housing and blower wheels - 5 years.
    b) Water recirculating pump - 2 years.
    c) Filter cartridges and all other parts - 1 year.

11. Unit shall be furnished with a variable frequency drive for fan speed control, and a 2-position control switch to turn the pump on or off. Provide VFD by one of the following manufacturers:

    a) ABB
    b) Yaskawa
    c) Franklin
    d) Mitsubishi
    e) Allen Bradley
    f) Danfoss
    g) Eaton
    h) prior approved equal

12. Unit shall be supplied with a 4-way blow diffuser sized to discharge air from unit with minimal static pressure loss and NC sound level not to exceed 20.

B. Approved manufacturers

1. Aerocool
2. Essick.
3. Champion.
4. Mastercool.
5. Prior approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in strict accordance with manufacturers recommendation.

B. Curb shall be installed per the requirements of the roofing manufacturer and shall form a water tight installation.

END OF SECTION 237533

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For split-system air-conditioning units to include in operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Units shall be designed to operate with HCFC-free refrigerants.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.
2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Air Conditioning; Div. of Carrier Corporation.
2. Fujitsu.
3. Mitsubishi.
4. LG
5. Daikin
6. Trane Company (The); Unitary Products Group.
7. Prior approved equal.

2.2 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Direct drive, centrifugal fan.

E. Fan Motors: Comply with requirements in Division 22 and 23 Section "Motors."

1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Scroll.
2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
3. Refrigerant Charge: R-410A.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 0 deg F.

H. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 22 and 23 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection, including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Additional Monitoring:

1. Monitor constant and variable motor loads.
2. Monitor variable frequency drive operation.
3. Monitor economizer cycle.
4. Monitor cooling load.
5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 4-inch- thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install ground-mounting, compressor-condenser components on polyethylene mounting base.

E. Install roof-mounting compressor-condenser components on equipment supports specified in Division 7 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

F. Install seismic restraints.

G. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 22 and 23 Section "Mechanical Vibration Controls and Seismic Restraints."

H. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
1.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 238126

SECTION 260000 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. General requirements which apply to all electrical aspects of the work.

B. Related Sections

1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents in order to provide a complete and coordinated project.

1.2 REFERENCES

A. The installation and commissioning of the Electrical System shall conform to all applicable codes, regulations, standards and specifications, including, but not limited to those listed below. These publications are referenced to by designation but not by edition. The latest edition accepted by the Authority Having Jurisdiction in effect at the time of bid shall govern.

1. State and Local Codes and Authority Having Jurisdiction (AHJ)
2. National Electric Code (NEC).
3. National Fire Protection Association (NFPA)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. American National Standards Institute (ANSI)
6. American Society for Testing and Materials (ASTM)
7. Insulated Cable Engineers Association (ICEA)
8. National Electrical Manufacturers Association (NEMA)
9. Federal Occupational Safety and Health Act (OSHA)
10. Underwriters Laboratories, Inc. (UL)
11. International Society of Automation (ISA)

1.3 DEFINITIONS

A. Refer to the Contract Drawings sheet E001 for a list of abbreviations associated with the Electrical System. In addition, the following definitions are used in this section:

1. AHJ – Authority Having Jurisdiction
2. I&C – Instrumentation and Controls
3. IS – Instrumentation Supplier
4. NEC – National Electric Code
5. VFD – Variable Frequency Drive
6. UL - Underwriters Laboratories, Inc.

1.4 ELECTRICAL SYSTEMS REQUIREMENTS

A. The Work is to provide all labor and materials necessary for erecting a complete and operational Electrical System, tested and ready for continuous use as described by the Contract Documents. The Electrical System shall be constructed in accordance with the Contract Documents, and Federal, State, and Local codes and regulations. In addition, the Work shall adhere to the following general provisions:

1. The Electrical Contractor shall obtain all necessary permits required by the AHJ. In addition, the Electrical Contractor shall ensure that all inspections required by the AHJ are coordinated, conducted and documented.

2. All work shall be completed in a neat, workmanlike manner in accordance with the latest NEC standards of installation under competent supervision.

3. The Electrical Contractor shall visit the job site prior to bidding to become familiar with existing conditions and other factors, which may affect the execution of the work. Include all related costs in the initial bid proposal.

4. Coordinate work with the utilities providing services on this project. This may include but is not limited to the electric utility, telephone utility, cable TV/Internet utility. All electrical work associated with utilities shall be provided and installed per the utility requirements.

5. All materials shall be new and of the best quality, manufactured in accordance with the requirements listed in part 1.2 of this section. The Contractor shall furnish and install the parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.

6. Protect all electrical material and equipment that is being stored or has been installed against damage by other trades, weather conditions, or any other preventable causes. Equipment damaged during shipping, storage or construction, prior to acceptance by the engineer or the owner, will be rejected as defective.

7. Leave the site clean. Remove all debris, empty cartons, tools, conduit, wire scraps and all miscellaneous spare equipment and materials used in the work during construction. All components shall be free of dust, grit and foreign materials, left as new before final acceptance of work. Damaged paint and finishes shall be touched up or repainted with matching color paint and finish.

8. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 40 degrees C, and specifically rated for the altitude indicated on the Plans. Electrical equipment not rated for operation at that temperature shall be provided with air conditioning to meet the manufacturers' operating temperature.

9. If any contradictions, contrasts, non-homogeneity, or inconsistency appears, the strictest criteria noted and the collective requirements in any and all of the Contract Documents shall apply.

10. The Electrical Contractor shall perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of

conduits, whether inside, or outside of the buildings and structures. The Electrical Contractor shall repair and patch where demolition has taken place in a manner to match existing original structure.

B. In order to provide a complete system, oversee and coordinate with all electrical equipment and services being provided outside of Contractor's scope.

1. The Engineer is responsible to ensure that equipment being supplied by others related to the electrical system complies with the requirements of the Contract Documents

2. The Electrical Contractor is responsible to coordinate the installation, commissioning and scheduling of equipment related to the I&C System that are provided by others.

C. Oversee and coordinate with all equipment and services being provided by the Contractor but outside of the Electrical Contractor's scope.

1. Inform all vendors and suppliers providing equipment related to the Electrical System the requirements of Division 26.

2. The Owner is not responsible for any additional costs incurred by requiring vendors and/or subcontractors to meet the requirements of Division 26.

3. If a vendor or supplier is unable to meet the requirements of Division 26, the Contractor may submit in writing to the Engineer the reasons for non-compliance. The Engineer will then evaluate the reasons and determine whether a solution may be determined or if a different vendor or supplier is required.

D. Prepare Electrical System Submittals as required by Division 26 and Section 013300. Coordinate with the IS and the requirements of Division 40 to ensure that all equipment being supplied by the Electrical Contractor and/or IS has been submitted.

E. Oversee the installation of the Electrical System.

F. Actively participate in loop testing as outlined in Division 40.

G. Actively participate in commissioning as outlined in Division 40.

H. Maintain record drawings.
1. Maintain on the construction site a set of the Electrical Drawings that shall be continuously marked up during construction.
   a. The drawings should be updated at least weekly and will be checked monthly by the Owner's representative.
   b. Upon completion of startup, submit the marked-up drawings to the Engineer for review and for drafting.

I. Prepare O&M manuals.
1. Provide O&M manuals in accordance with Section 017823.

J. Provide training on electrical equipment that has been installed.

1.5 ACTION SUBMITTALS

A. General
   1. Submittals for Division 26 shall meet the requirements of Section 013300 Contractor Submittals. In addition, the following requirements shall be met:
      a. Submittals shall include bills of materials with quantities, makes, models, exact part numbers and descriptions.
      b. Edit all submittals such that only pertinent information is submitted. Neatly cross out information that does not apply, options that are not being supplied, etc.
      c. Show product dimensions, construction and installation details, wiring diagrams, and specifications.
      d. If there are exceptions to the Contract Drawings and Specifications, provide a list of exceptions with detailed explanations for the exceptions. The Engineer will review the list of exceptions and determine whether a solution may be determined or if the exception(s) will not be allowed.
   2. Furnish submittals required by each Section within Division 26.
   3. When submitting on equipment, use the equipment and instrumentation tags depicted in the Contract Drawings.

B. Recommended Spare Parts Submittal
   1. Submit a list of spare parts for all of the equipment associated with the Electrical System. The list of spare parts shall include list pricing for each item.
   2. Provide the name, address and phone number for each manufacturer and manufacturer's local sales representative.
   3. Indicate whether or not the spare parts are being provided under this contract or not.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. All equipment supplied for this project shall meet the requirements of the NEC and shall be listed by and bearing the label of the UL.

B. The Electrical Contractor shall be a company that has been actively involved in the installation and commissioning of Electrical Systems for a minimum period of five years.

C. The Electrical Contractor shall have adequate facilities, manpower and technical expertise to perform the Work associated with the Electrical System and as outlined by the Contract Documents.

D. The Electrical Contractor shall have similar project experience of at least four successfully completed projects for a similar wastewater system. The Electrical Contractor company must have performed similar work for these projects as required herein.

PART 2 - PRODUCTS

2.1 MATERIALS AND METHODS

A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged or dirty materials, equipment, and parts are not considered to be new and unused and will not be accepted.

B. Field verification of scale dimensions on Plans is directed, since actual locations, distances, and levels will be governed by actual field conditions. The Contractor shall also review architectural, structural, yard, mechanical, and other Plans, and the accepted electrical and mechanical shop drawings, and shall adjust their work to conform to the conditions indicated therein.

C. The fabricator of major components, such as distribution panelboards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein. Where possible, the major components shall be manufactured and supplied by the same fabricator.

2.2 MANUFACTURERS

A. All equipment provided for the Electrical System shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

B. Refer to various Division sections for individual equipment manufacturers. Indicated manufacturers are subject to strict compliance with the specifications and complete project documents. The reference to a particular manufacturer does not relieve the Electrical Contractor from conforming to the specified requirements.

C. When providing like electrical components they shall be furnished by a single manufacturer and shall be consistent throughout the project. For example, a 20A 2-way light switch in one building should match a 20A 2-way light switch in another building in both make, model and features.

2.3 EQUIPMENT ASSEMBLIES

A. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record shop drawings.

B. Custom fabricated electrical control panels, and enclosures shall bear a serialized UL label affixed by a local inspector, and the serial number shall be submitted with the assembly record shop drawings.

2.4 OPERATING CONDITIONS

A. The Electrical System shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:
   1. Environment: Wastewater Treatment Plant.
   2. Temperature Extremes: -4°F to 104°F (Outdoors); 40°F to 104°F (Indoors).
   3. Relative Humidity: 20% to 90%, non-condensing.

B. Indoor and outdoor electrical equipment shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain electrical devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The Contractor shall provide power wiring for these devices. Enclosures suitable for the environment shall be furnished. Electrical equipment in hazardous areas shall be suitable for and rated for use in the particular hazardous or classified location in which it is to be installed.

2.5 SEISMIC RESTRAINT

A. The construction area is classified by the International Building Code (IBC) as Seismic Class C. The Code requires that not only the structures, but also major electrical components be designed and installed in a manner which will preclude damage during a seismic event. All electrical equipment shall be securely anchored and seismic braced in accordance with regulations contained in the most recent adopted edition of the IBC, and the Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) "Guidelines for Seismic Restraints of Electrical Systems".

B. Units mounted and secured directly to structure shall be provided with connectors of sufficient strength to meet the restraining criteria.

C. All electrical equipment which is securely anchored (hard mounted) to the building or structure shall have supports designed to withstand lateral and vertical "G" loadings equal to or greater than IBC requirements and SMACNA guidelines.

D. Shop drawings are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, load/deflection data, center of gravity, standard connections, manufacturer's recommendations, and behavior problems (vibration, thermal, expansion, etc.) associated with equipment.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. After completion of shop assembly, factory test, and approval, equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.

B. Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

C. Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the PCIS. Identification shall be prominently displayed on the outside of the package.

D. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. If such tests reveal defects, the equipment shall be replaced.

3.2 MANUFACTURER'S SERVICES

A. Manufacturer's services shall be furnished for the following equipment:
   1. Vendor supplied equipment that contain programmable controllers, operator interfaces and/or instrumentation that requires site calibration.
   2. Equipment that is equipped with VFD's
   3. Electrical generation equipment

3.3 INSTALLATION

A. The Electrical System indicated throughout the design is diagrammatic and therefore locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Contractor shall make such changes without additional cost to the Owner.

B. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for clarification, prior to purchasing and installing equipment.

C. The alignment of equipment and conduit shall be adjusted to accommodate architectural changes, or to avoid work of other trades, without extra expense to the Owner.

D. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

E. The Electrical Contractor shall layout and install electrical work prior to placing floors and walls. Furnish and install sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement. Dimensions indicated for electrical equipment and their installation are restrictive dimensions.

F. The Electrical Contractor shall furnish and install inserts and hangers required to support conduits and other electrical equipment. If the inserts, hangers, sleeves, or other mounting hardware are improperly placed, or installed, the Contractor shall do necessary work, at their own expense, to rectify the errors.

G. The Electrical System is integrally connected to I&C, mechanical and structural systems. Coordinate with these other disciplines the installation of these related components.

H. Electrical equipment shall be anchored by methods that comply with seismic requirements applicable to the Site.

I. The Contract Documents show necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the Engineer for approval prior to commencing that Work. Such changes shall not be a basis of claims for extra Work or delay.

J. Instrumentation, control panels, wiring and all other I&C equipment shall be properly tagged and/or labeled per the requirements of Section 260553.

K. Installation of the I&C System shall be according to the finalized Loop Drawings

3.4 FACTORY ACCEPTANCE TESTING (FAT)

A. The IS shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the Engineer and Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, and other pertinent systems and devices. A minimum of 10 days notification shall be furnished to the Engineer prior to testing. No shipments shall be made without the Engineer's approval.

B. For each FAT, the IS shall develop and submit a FAT Plan and Procedure Document within 10 days of the FAT. The FAT Plan and Procedure shall as a minimum shall have the following:
   1. Descriptions of test methods to be performed during the FAT.
   2. FAT Schedule and Procedure
   3. FAT Checklists that allow for sign-off and comments for each test method and procedure.

C. Control Panel Completion Test Methods: The following test methods should be performed during the FAT for each control panel:
   1. Completed Shop Drawings: Demonstrate that the control panel has been built according to the shop drawings and that the shop drawings are accurate.
   2. Panel Layout: Demonstrate that the control panel has been laid out as designed and as required by Division 40.

3. Power Distribution: Demonstrate all power distribution circuits, including but not limited to AC power circuits, UPS operation, signals and circuits and DC circuits.
4. Control Circuits: Demonstrate the correct installation of each control circuit. Using a signal generator or multi-meter, show the correct operation of each input, output, relay, barrier, buttons, switches, or any other control device. Demonstrate the proper functionality of any hard-wired interlocks that may be associated with each control circuit.
5. Panel Networking/Communications: If any form of communications is associated with the control panel, verify the proper operation of each communication port and link.

D. Control Loop Test Methods: In order to demonstrate that the control panel will provide its function as intended, provide the following control loop test methods. If programming for the control panel is provided by others, coordinate with the programmer to have all programming completed and tested prior to the FAT. If needed, coordinate to have the programmer present for the FAT.
1. Alarm Functions: Verify and/or simulate each alarm condition associated with each control loop.
2. Local Manual and Auto Functions: Verify and/or simulate each Local Manual and/or Auto function associated with each control loop.
3. SCADA Manual and Auto Functions: Verify and/or simulate each SCADA Manual and/or Auto function associated with each control loop.
4. Control Loop Interlocks: Demonstrate the functionality of any software interlocks that may be associated with each control loop.

E. If the FAT does not pass and needs to be repeated, the IS shall be responsible for additional per diem costs incurred by the Engineer and Owner.

F. All changes and/or corrections made during the FAT shall be noted on the checklists.

G. Following completion and approval of all FAT, provide the finalized checklists to the Engineer and as part of the equipment shop drawings.

3.5 FIELD QUALITY CONTROL

A. Allow for inspections by the Engineer and/or Owner of the I&C System at any time during the construction. Inspections shall be conducted to verify that the installation is per the requirements of the Contract Documents.

3.6 CALIBRATION

A. Devices provided under Division 40 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.

C. Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.

D. Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.

F. For each instrument calibration, provide a calibration sheet and update the corresponding TR20 Instrument Form with the new calibration data. The Calibration sheet shall include the following as a minimum:
1. Date of calibration
2. Project Name.
3. Tag Number.
4. Manufacturer, model and serial number.
5. Calibration data including range, input, output and measurement at each calibration point.
6. Space for comments.
7. Space for sign-off by party performing calibration.

G. A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The IS shall sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

3.7 LOOP TESTING

A. Each control loop shall have been installed according to the finalized loop drawing. Prior to the commencement of loop testing, the following pre-requisites should have been met:
1. All associated equipment, conduit and wire has been permanently installed, terminated and inspected.
2. All wiring has been properly pulled, terminated and labeled.
3. Each wire has been tested with a point-to-point test.
4. All control panels and electrical equipment have been checked out and tested as required by Division 26.
5. All instrumentation has been appropriately installed and calibrated.
6. Loop Test Forms for each loop to be tested have been created and will be available during the loop testing.

B. Each loop test shall have a Loop Test Form prepared and ready prior to each loop test. The loop test form shall have the following:
1. Loop Number and Description
2. Check-Off List with room for sign-off and dated by the IS, Programmer, and Owner’s Witness as well as room for comments. The list of items to be checked off for each loop should include but is not limited to the following:
    a. Each power distribution circuit.
    b. Each control circuit.
    c. Each alarm circuit.
    d. Each PLC input/output point.

e. Each Local Manual, Local Auto, SCADA Manual & SCADA Auto function.
f. Each hard-wired and software interlock.

C. Upon completion of the above pre-requisites for loop testing, the IS shall oversee and coordinate each loop test. The IS is responsible to be present for all loop testing, whether the equipment was supplied by the IS or not. The IS is responsible to have all responsible parties associated with each loop present. This includes but is not limited to manufacturer representatives, vendor technicians, electrical installers, mechanical installers, and programmer. The IS shall coordinate with the Owner and Engineer to allow for witnessing of loop testing as deemed necessary by the Owner and Engineer.

D. Issues that arise during loop testing should be addressed and fixed immediately. If it is not feasible to immediately fix the issues, the loop testing should be re-scheduled as soon as possible to avoid delays. Any costs associated with re-testing and requiring all parties to return to the site shall in no way be incurred to the Owner.

E. Following a successful loop test, the appropriate parties should sign and date the Loop Test Forms. All Forms shall be certified and submitted to the Engineer as part of the O&M Manuals.

F. Following loop testing, in no way should any parts of the loop be modified. In no way shall any wiring be re-routed or re-terminated. If any such work occurs, all affected loops shall be re-tested at no expense to the Owner.

3.8 COMMISSIONING

A. The IS shall oversee, coordinate and be present during all commissioning activities. The IS shall be responsible for obtaining the assistance of the Contractor and Subcontractors as may be required for commissioning activities.

B. Commissioning shall commence after acceptance of wire test, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with Contract requirements. Pre-commissioning shall demonstrate proper operation of every system with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

C. Commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system commissioning and test requirements have been satisfied.

D. Where feasible, system commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The

stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software-based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software-based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

E. Electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

3.9 TRAINING

A. Provide training in accordance with Section 260000.

B. Develop a Training Plan for the training requirements of Division 40 and submit it to the Engineer for approval. Coordinate with the Engineer and Owner the time and locations of each training session. Schedule the trainings for after the equipment has been pre-commissioned.

C. As part of the Training Plan, submit a résumé for each individual to be providing training. Training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

D. Each training session shall include a written agenda.

E. The Contractor shall train the Owner's personnel on the maintenance, calibration and repair of instruments provided.

F. Within 10 days after the completion of each session, the Contractor shall submit the following:
   1. A list of Owner personnel who attended the training.
   2. A copy of the training materials used during the session with notes, diagrams and comments.

END OF SECTION 260000

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. All conductors, conductor insulation and multiconductor cables shall comply with NEMA WC 70.

B. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction Number 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape. Conductors #6 AWG or smaller shall be THWN-2 or XHHW-2. Number 4 and larger shall be XHHW-2.

C. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600V.

D. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than #12 AWG, unless specifically noted on the Plans. Control wires shall be allowed to be #14 so long as there is appropriate protection (fuse or circuit breaker sized at 15A or less).

E. Multi-conductor tray cables shall be rated 600 volts, listed by UL as Type TC cable or ITC for instrumentation cable only per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/Terminators shall be watertight and manufactured of the same material as the cabling system referenced elsewhere in division 26.

F. Multi-conductor tray cables to be installed in classified areas shall be armored, rated 600 volts, listed by UL as Type MC-HL cable per Article 340 of the NEC. The individual conductors shall be UL listed as Type XHHW, with a sunlight-resistant overall jacket. Conductor sizes shall be the same as for power and lighting wire and control wire above. Connectors/terminators shall be rated for classified areas and submitted upon accordingly.

G. All wiring shall be as indicated on the Plans. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM, and ICEA, and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.

H. VFD Cable:

1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
3. Comply with UL requirements for cables in direct burial or Classes I and II, Division 2 hazardous location applications.

I. The following table describes the conductor color code that shall be followed:

	120/208VAC	**480VAC**	**12VDC**	**24VDC**	**24VAC**
Phase 1	Black	Brown			
Phase 2	Red	Orange			
Phase 3	Blue	Yellow			
Neutrals/Commons	White	White	Orange/White	Blue/White	Yellow/White
Ground	Green	Green	Green	Green	Green
Control	Red		Orange	Blue	Yellow

J. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Insulated Wire Corporation
2. Cablec Corporation

3. Okonite Company
4. Southwire Company
5. Or Approved Equal

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

B. Connectors and splices shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.

C. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A.

D. Splices in wires No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.

E. Insulated conductor splices below grade or in wet locations shall be one of the following Types where specifically called out on the project drawings:
1. Sealed type conforming to ANSI C119.1
2. Shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing
3. By pouring a thermosetting resin into a mold that surrounds the joined conductors
4. Gel Tap splice (NSI Industries ESGTS)

F. Bare conductor splices in wet locations or below grade shall be of the exothermic type.

G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Power Systems, Inc.
2. O-Z/Gedney; EGS Electrical Group LLC.
3. 3M; Electrical Products Division.
4. Or Approved Equal

2.3 PULLING LUBRICANT

A. All cables shall be properly coated with a water-based (wax-based is not acceptable) pulling compound before being pulled into conduits so as to prevent mechanical damage to the cables during installation. Lubricants shall be approved by the cable manufacturer for use with the cable being installed.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Polywater

2. Ideal Aqua-Gel
3. Or Approved Equal

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Stranded for all sizes.

B. Branch Circuits: Copper. Stranded for all sizes.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway

B. Exposed Feeders and Branch Circuits: Type THWN-2 or XHHW-2 based on wire size requirements described in Part 2, single conductors in raceway. Multiconductor Tray Cable type TC shall be used where runs are to be in cable trays as shown on the drawings.

C. Feeders and Branch Circuits Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THWN-2 or XHHW-2 based on wire size requirements described in Part 2, single conductors in raceway. Metal-clad cable, Type MC shall be allowed in ceilings that are considered dry and non-corrosive areas.

D. Feeders and Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THWN-2 or XHHW-2 based on wire size requirements described in Part 2, single conductors in raceway.

E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

F. Class 1 Control Circuits: Type THWN-2, in raceway. Multiconductor Tray Cable type TC shall be used where runs are to be in cable trays as shown on the drawings.

G. Class 2 Control Circuits: Type THWN-2, in raceway. Power-limited tray cable shall be used where runs are to be in cable tray as shown on the drawings.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the Engineer's approval. Conductor splices shall not be made in underground junction boxes or manholes unless specifically noted on the plans.

C. Each feeder and branch circuit shall be installed in its own individual conduit unless combining feeder and branch circuits is permitted as defined in the following:

1. As specifically indicated on the Plans.
2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity de-rated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.
3. When field conditions dictate, and written permission is obtained from the Engineer.

D. Use manufacturer-approved pulling compound or lubricant when pulling conductors; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.

F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted above. 12VDC, 24VDC and 48VDC control circuits may be combined into one conduit. 120/208/240VAC control circuits shall be isolated from all DC control circuits. 277/480VAC circuits shall be isolated from all other voltages.

G. Single conductor cable in cable trays shall be No. 1/0 or larger and shall be of a type listed and marked for use in cable trays. Tray cable smaller than 1/0 shall be multi-conductor, with outer jacket.

H. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

I. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

J. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

K. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

L. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

M. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

    a. All conductors with voltages at 277V or higher and corresponding neutrals and grounds.

    b. All conductors #8 and larger.
    c. All motor leads and corresponding grounds.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Instrumentation cabling.
2. Low-voltage control cabling.
3. Control-circuit conductors.
4. Identification products.

B. Related Sections

1. For structured cabling systems, including fiber optic cabling and CAT6 cabling refer to Section 409533.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

B. Test each pair of each cable for open and short circuits.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Conduit and Boxes: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 INSTRUMENTATION CABLE

A. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Plans and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog and low voltage digital signals.

B. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

C. The conductors shall be tin-plated, soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

D. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

E. Pairs installed in a cable tray shall have a UV resistant jacket, and shall have a jacket intended for cable tray use.

2.3 RS-232 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.4 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

C. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.

2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

D. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.6 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded tin-plated copper, Type THHN-THWN, in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.7 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Panduit Corp.
3. Or Approved Equal.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for installation of conduits and wireways.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed or in the corner of room if multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 12 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 24 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 48 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 6 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: 3 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

5. Separation between Cables and Electrical Motors and Transformers: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 6 inches.

3.3 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. For data communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 260523

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Grounding systems and equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Stranded Conductors: ASTM B 8.
2. Tinned Conductors: ASTM B 33.
3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 3/4 inch in diameter and 10 feet long.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductors all conductor sizes.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum. Bury at least 24 inches below grade.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded or approved compression connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems", and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least two test wells for each service unless otherwise indicated. Install at the ground rods electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 LABELING

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Make tests at ground rods before any conductors are connected.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 ACTION SUBMITTALS

A. Product Data: For steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
      h. Or Approved Equal.

   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and FRP hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
5) Or Approved Equal.

2. Mechanical-Expansion Anchors: Insert-wedge-type, galvanized steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.
      6) Or Approved Equal.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single or two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may not be used.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and GRS may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 3.0 mils.

B. Touchup: Comply with requirements in Section 098000 "Protective Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

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SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install conduits as required, and as shown on the Plans. Materials employed shall be as shown on the Plans.

1.2 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. If changes from the Plan are proposed, shop drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.

C. Proposed routing of conduits buried under floor slabs-on-grade.

D. Identify conduit by tag number of equipment served or by circuit schedule number.

E. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc.

F. Proposed location and details of construction for openings in slabs and walls for raceway runs.

G. Refer to Section 26000 “General Electrical Requirements” for further submittal requirements.

1.3 REFERENCES

A. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc-Coated.

B. National Electric Manufacturers Association (NEMA): RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

C. Underwriters Laboratories Inc. (UL):

1. 1, Flexible Metal Conduit.
2. 6, Rigid Metal Conduit.
3. 360, Liquid-Tight Flexible Steel Conduit.
4. 467, Grounding and Bonding Equipment.
5. 514, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers.
6. 651, Schedule 40 and 80 Rigid PVC Conduit.
7. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
8. 884, Underfloor Raceways and Fittings.
9. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. Exposed conduits in an unclassified or non-hazardous area shall be Aluminum Rigid Conduit unless specifically indicated otherwise on the Plans. Conduits in hazardous, or damp areas shall be Aluminum Rigid Conduit unless otherwise indicated. Conduits in corrosive areas shall be PVC Schedule 80 unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC Schedule 40, unless otherwise indicated. All conduits concealed in block walls or steel framing shall be EMT with compression fittings unless otherwise indicated. Set screw type fittings in EMT conduit will not be accepted. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch. No underground conduit shall be less than one inch.

B. Condulets type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers. All condulets located outdoors, damp or wet locations shall be weather tight.

C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.

D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout. Conduit systems shall be water tight.

E. Expansion fittings shall be OZ type AX with jumper for exposed locations and type DX at structural expansion joints, Spring City, or equal. Conduits shall have expansion fittings in accordance with NEC.

F. The conduits and fittings shall be supported per NEC requirements as a minimum.

G. Sealing fittings shall be provided for classified areas per the NEC requirements in hazardous or corrosive areas. Fittings shall be poured after the final walk-thru unless otherwise directed in writing by the engineer.

2.2 GALVANIZED RIGID STEEL (GRS)

A. Conduits and couplings shall be hot-dipped galvanized with zinc coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1 standards, as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, Triangle PWC, or equal.

B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. Instead buried steel conduit shall be PVC coated.

2.3 PVC COATED GALVANIZED RIGID STEEL (PVC-GRS)

A. PVC coated GRS conduit shall be installed where shown on the Plans or elsewhere specified and shall conform to NEMA RN-1 and ANSI C80.1 standards.

B. The zinc surface of the conduit shall remain intact and undisturbed on both the inside and the outside of the conduit throughout the preparation and application processing. A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 0.040-inch (40 mil).

C. A loose coupling shall be furnished with each length of conduit. A PVC coating shall be bonded to the outer surface of the coupling and a PVC sleeve equal to the outside diameter of the uncoated conduit shall extend beyond both ends of the coupling approximately one pipe diameter or 1-1/2 inches, whichever is smaller. The wall thickness of the coating on the coupling and the sleeve shall be a minimum of 0.055-inch (55 mil).

D. A PVC coating shall be bonded to the inner and outer surface of all conduit bodies and fittings and a PVC sleeve shall extend from all hubs. The wall thickness of the coating on conduit bodies and fittings and the sleeve walls shall be identical to those on couplings in length and thickness. The covers on all conduit bodies shall be coated on both sides and shall be designed to be completely interchangeable. The inside of conduit bodies shall remain undisturbed in the processing.

E. Type 304 stainless steel screws shall be furnished and used to attach the cover to the conduit body. All coated material shall be installed and patched according to the manufacturer's recommended installation and patching instructions.

F. Conduit straps shall be PVC coated or stainless steel.

G. PVC coated conduits and fittings shall be as manufactured by Kor Kap Corporation, Occidental Coating Company, Rob-Roy, or equal.

H. PVC coated flexible conduits shall be liquid and vapor-tight and manufactured in accordance with UL 360 standards.

2.4 RIGID NONMETALLIC – PVC

A. Where specifically indicated on the Plans, or elsewhere specified, conduit may be high density Schedule 40 or Schedule 80 as indicated, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784, NEMA TC-2, ANSI C33.91, and UL 651 standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.

B. Where conduit concrete encasement is indicated on the Plans, conduit supports shall be installed at five-foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit & Cable, or equal.

2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Liquidtight flexible metal conduit shall be liquid and vapor-tight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90 degrees Celsius.

B. For corrosive locations, liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors and PVC coated fittings shall be utilized.

C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1 1/2 " or larger. Flexible conduits and connectors for 1 1/4 " and smaller shall be listed for grounding.

D. For non-corrosive locations, connectors for liquidtight flexible conduit shall be aluminum, furnished with a sealing ring and locknut, and suitable for wet locations. For corrosive locations, connectors shall be PVC with internal ground conductor for bonding.

2.6 ELECTRICAL METALLIC TUBING (EMT)

A. Per UL Standard for Electrical Metallic Tubing No. 797. Galvanized mild steel with interior coat of enamel.

B. Fittings shall be steel set-screw type. Cast type, indenter type or compression steel fittings are not acceptable.

C. Approved for plan specified locations only. Approved for conduits concealed in block walls and concealed in steel framed walls. Not approved for process areas where wash down or high humidity conditions exist.

2.7 ALUMINUM CONDUIT

A. Aluminum hardware and conduit shall be isolated from all dissimilar materials as appropriate.

1. Isolation from dissimilar metals in channel or support by a single layer of scotch #33+ or approved equal.
2. Isolation from concrete shall be by neoprene gaskets.
3. Aluminum shall not be used for concrete penetrations unless isolated with a half lapped wrap of Scotchwrap or equal..

B. Aluminum conduit shall contain less than 0.4% copper.

2.8 STAINLESS STEEL CONDUIT

A. Stainless Steel Conduit conduit is approved for all exposed conduit locations. Prior approval from the engineer must be obtained when substituting for PVC coated.

B. Stainless Steel conduit and all fittings and support hardware shall be 316 SS.

2.9 CABLE TRAY SYSTEM

A. Provide cable tray systems composed of straight sections, fittings, and accessories as defined in the latest NEMA Standards publication VE-1 - Ventilated Cable Tray.

1. Provide cable trays and fittings shall constructed of materials suited for the area classification as noted below.
2. Provide cable trays shall be of the ladder type with 9 inch rung spacing.
3. Provide tray sizes with a 3, 4, 5, or 6-inch minimum usable load depth, as indicated on the drawings.
4. Provide loading capacities that meet the NEMA weight classification with a safety factor of 1.5.
5. In corrosive, damp, or Hazardous locations, provide cable trays manufactured of aluminum.
6. In non-classified areas provide cable trays manufactured of fiberglass or aluminum.
7. Separate power, control, signal and communications cables by grounded metallic dividers or run in separate trays.
8. Manufacturer, or Approved Equal

    a. Husky
    b. B-Line
    c. T.J. Cope

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.

C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the condulet type.

D. Conduit runs in buildings and structures shall be concealed where possible except as specifically noted, or accepted by the Engineer.

E. Conduit runs shall not interfere with the proper and safe operation of equipment, and shall not block or interfere with ingress or egress, including equipment removal hatches.

F. Exposed conduits shall be securely fastened with clamps, or straps, intended for conduit use. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit to vibrating equipment such as motors, fans, and transformers. The maximum length of flexible conduit shall be 3 feet, unless approved in writing by engineer. Flexible conduit shall not be used for electrician's convenience where rigid conduit could be used.

G. Conduit runs on water-bearing walls shall be supported one inch away from the wall on an accepted channel. When channel coating, is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

H. Conduit shall be thoroughly reamed to remove burrs. Aluminum Rigid Conduit shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying fittings.

I. Bushings and lock nuts or hubs shall be used at conduit terminations. Conduit, bushings, locknuts, and enclosures shall be fastened to the conduit system prior to pulling wire. Splitting the bushings for installation will not be accepted. Hubs shall be used in all process areas outside of electrical rooms unless otherwise specified. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the Engineer. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string. Splices shall be made in junction boxes only. Splices in conduit bodies will not be accepted.

J. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the particular application.

K. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects, or obstructions remain in the conduit prior to pulling in conductors.

L. After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used. Test results should be submitted to the engineer.

M. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.

N. Provide trenching, backfill, and compaction for conduits installed underground.

O. Raceways running parallel to hot water or steam piping shall maintain a distance of 6 inches from the piping.

P. Raceways crossing steam or liquid filling piping shall cross above the piping.

Q. In slab conduits, shall be covered by a minimum of 2 inches of concrete.

R. Conduits of the same duty (480V Power, 120V Power, 120V Controls and signals) shall have a minimum separation of 2 inches between conduits.

S. Conduits and raceways carrying signal wiring shall have a minimum separation of 12 inches from 480V power raceways, 6 inches from 120V power raceways, and 4 inches from 120V control raceways.

T. Raceways with 120V Control shall maintain a distance of 12 inches from 480V power raceways, 6 inches from 120V power raceways.

U. Raceways with 120V power shall maintain a distance of 6 inches from 480V power raceways.

3.2 CABLE TRAYS

A. Provide cable trays in strict accordance with the manufacturer's printed instructions.

B. Allowable cable fill areas shall meet NEC Article 392 - Cable Trays requirements.

C. Verify cable tray fills prior to installation based on cables and trays actually provided.

D. Maintain continuous grounding of cable trays including bonding jumpers in accordance with the requirements of NEC Article 392.

E. Install cable trays using hangers and supports on 8-foot centers, maximum.

F. Install cable trays to walls as the primary method of support where possible.

G. If support from the ceiling is the only alternative, use hangers and supports on 6-foot centers, maximum.

H. Ensure that proper separation between duties as detailed in 3.1.

END OF SECTION 260533

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SECTION 260534 – ENCLOSURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This specification includes enclosures to house electrical controls, instruments, terminal blocks, and serve as junction boxes where shown on the Drawings.

1.2 RELATED SECTIONS

A. For Raceways and Boxes for Electrical Systems see Section 260533 “Raceways and Boxes for Electrical Systems”.

1.3 SUBMITTALS

A. Products shall be submitted in accordance with Section 260000 “General Electrical Requirements”, and elsewhere in the Contract Documents, prior to installation.

1.4 MANUFACTURERS

A. Enclosures shall be manufactured by one of the following:
   1. Hoffman
   2. Saginaw
   3. Schneider
   4. Or Approved equal

PART 2 - PRODUCTS

2.1 STEEL

A. Enclosures shall be fabricated from 14-gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.

B. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket. All wires entering or leaving the enclosure shall terminate on terminal strips. All wires and terminals shall be clearly identified as specified elsewhere in these specifications.

C. Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Plans should be checked for special conditions.

2.2 NEMA RATING

A. Unless otherwise indicated on the Plans, enclosures shall be NEMA 12 for indoors, NEMA 4X for corrosive areas, and NEMA 4 for outdoor installations. NEMA 4X enclosures shall be stainless steel, unless noted otherwise. NEMA 4X enclosures shall also be used in wet or wash down areas.

B. All enclosures used in classified areas shall be NEMA 7.

C. In Wastewater facilities, all enclosures in process areas shall be NEMA 4X stainless steel. Enclosures in electrical rooms, meeting rooms, offices and shops shall be NEMA 12 unless otherwise specified.

D. Areas not specified in Water Treatment, Wastewater, or other water related facilities shall be approved by the engineer for NEMA type prior to installation.

2.3 FIBERGLASS

A. Enclosures shall be heavy-duty, compression molded, fiberglass reinforced polyester, high impact, heat resistant, NEMA 4X.

B. Fiberglass enclosure shall not be used in areas exposed to UV or Sunlight

C. Enclosure shall be provided with Metal latches that are lockable

2.4 POLYCARBONATE

A. Enclosures shall be heavy-duty, compression molded, polycarbonate, high impact, heat resistant, NEMA 4X.

B. Where indicated a clear door shall be provided

C. Enclosure shall be provided with Metal latches that are lockable

PART 3 - EXECUTION

3.1 INSTALLATION

A. Enclosures shall be installed as indicated on the Plans, and according to manufacturer's instructions.

B. Enclosures shall be properly grounded and shall include ground straps connected to hinged doors and accessories.

C. Enclosures shall be placed to reduce penetrations in the top of the enclosure. All penetrations shall be thru the side or bottom of the enclosure unless approved by the engineer prior to installation.

END OF SECTION 260534

SECTION 260543 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Conduit, ducts, and duct accessories for concrete-encased duct banks.
2. Handholes and boxes.
3. Manholes.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For accessories for handholes and boxes.

B. Shop Drawings for Factory-Fabricated Handholes and Boxes: Include dimensioned plans, sections, elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUIT

A. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

B. Underground Plastic Utilities Duct: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.

    a. Color: Red dye added to concrete during batching.
    b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.3 HANDHOLES AND BOXES

A. Description: Comply with SCTE 77.

1. Color: Gray or Green, depending on location.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.

3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. Christy Concrete Products.
d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "General Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Resto-revegetation and include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants and Planting."

D. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.2 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid Aluminum conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 3 inches between ducts for like services, and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 24 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured fiberglass duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow. No fiberglass conduit shall be exposed above grade.
9. Stub-Ups: Use manufactured fiberglass conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple fiberglass or Aluminum conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.

10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "General Earthwork" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Section 312000 " General Earthwork."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Section 312000 " General Earthwork."
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

10. Install manufactured fiberglass conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple fiberglass or aluminum to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.

11. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

3.3 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.4 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.6 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 260543

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. PVC Schedule 40 pipe sleeves may be used unless required otherwise for fire rating

2. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
3. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Stainless sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Channel support systems.
   2. Restraint cables.
   3. Hanger rod stiffeners.
   4. Anchorage bushings and washers.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

   1. Site class, building code and Design Spectral Response Acceleration as defined on the Contract Drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

   3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

      a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
    c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

D. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
6. Mason Industries.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.

E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchors and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

H. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

I. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
2. Test at least four of each type and size of installed anchors and fasteners selected by Engineer.
3. Test to 90 percent of rated proof load of device.
4. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples of each color, lettering style and other graphic representation required for each identification material or system.

C. Table or list of equipment, panel and disconnect switch labels.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Write-On Tags shall not be allowed.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label. Heat shrink tubing, or sleeve type wire markers are also acceptable.

A. Write-On Tags shall not be allowed.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

C. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label. Heat shrink tubing, or sleeve type wire markers are also acceptable.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

D. Write-On Tags shall not be allowed.

2.5 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft.
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

D. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 CONDUCTOR LABELING SCHEME

A. All control and instrumentation conductors shall be labeled with a “To/From” labeling scheme. Each conductor label shall have two lines of text. The first line of text shall indicate the enclosure and terminal where the wire is to terminate on the other end. The second line of text shall indicate the enclosure and terminal where the wire is to terminate on this end. The following example illustrates the “To/From” labeling scheme:

1. A wire is connected between a VFD and an LCP. The VFD equipment tag is VFD-100 and the LCP equipment tag is LCP-100. The connecting terminal at the VFD enclosure is terminal “5”. The connecting terminal at the LCP is terminal “7”. This wire would have the following labels:
   a. The wire label at the VFD end:
      Top Line: “LCP-100 : 7”
      Bottom Line: “VFD-100 : 5”
   b. The wire label at the LCP end:
      Top Line: “VFD-100 : 5”
      Bottom Line: “LCP-100 : 7”

3.2 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.3 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Install labels at 10-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. UPS.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

a. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

b. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.
b. Controls with external control power connections.

J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.
2. Buck-boost transformers.

1.2 ACTION SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Indicate dimensions and weights.

1. Wiring Diagrams: Power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

B. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ACME Electric Corporation; Power Distribution Products Division.
2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
3. Controlled Power Company.
4. Eaton Electrical Inc.; Cutler-Hammer Products.
5. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
6. General Electric Company.
7. Hammond Co.; Matra Electric, Inc.
8. Magnetek Power Electronics Group.
9. Micron Industries Corp.
10. Myers Power Products, Inc.
11. Siemens Energy & Automation, Inc.
12. Sola/Hevi-Duty.
13. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Ventilated, NEMA 250, Type 3R.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

M. Wall Brackets: Manufacturer's standard brackets.

2.4 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: Gray.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated plastic or metal nameplate. Nameplates are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Section 26 05 48 "Vibration and Seismic Controls for Electrical Systems."

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

a. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
b. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
c. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.3 ADJUSTING

A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
3. Include schematic and wiring diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA PB 2.

C. Comply with NFPA 70.

D. Comply with UL 891.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, the following manufacturers are approved:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Panel mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V

D. Main-Bus Continuous: 2500 A.

E. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

F. Enclosure: Steel, NEMA 250, Type 1.

1. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.

G. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

H. Space-Heater Control: Thermostats to maintain temperature of each section.

I. Space-Heater Power Source: 120-V external branch circuit.

J. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

M. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
3. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

N. Phase and Neutral Buses and Connections: Three phase, four wire unless otherwise indicated. Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.

1. Ground Bus: 1/4-by-2-inch minimum size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors.
2. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
3. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables.

O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. LED indicator lights for power and protection status.
3. Audible alarm, with silencing switch, to indicate when protection has failed.
4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device.

5. Transient-event counter set to totalize transient surges.

B. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

C. Withstand Capabilities: 5000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

D. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall be as follows:

1. Line to Neutral: 800 V for 480Y/277.
2. Line to Ground: 800 V for 480Y/277.
3. Neutral to Ground: 800 V for 480Y/277.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    f. Communication Capability: Din-rail-mounted communication module with functions and features compatible with power monitoring utilizing Modbus TCP.
    g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
i. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time time adjustments.
c. Ground-fault pickup level, time delay, and I^2t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Integral communication module with Modbus TCP or Ethernet IP.
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: 120-V ac.

C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Boltswitch, Inc.
b. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
c. Pringle Electrical Manufacturing Company, Inc.
d. Square D; a brand of Schneider Electric.

2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

3. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
4. Service-Rated Switches: Labeled for use as service equipment.
5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

    a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

D. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

    a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
    b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

3. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
4. Service-Rated Switches: Labeled for use as service equipment.
5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

    a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

F. Fuses are specified in Section 262813 "Fuses."

2.4 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
3. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Megawatts: Plus or minus 2 percent.
e. Megavars: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

B. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.7 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Receive, inspect, handle, store and install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Install spare-fuse cabinet.

H. Comply with NECA 1.

I. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

J. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Switchboard will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262413

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section covers electrical panelboards.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 26 00 00, and the Contract Documents, prior to installation.

B. Panel layout with alphanumeric designation, branch circuit breaker sizes and types, AIC rating, bus sizes, bus material and other characteristics.

1.3 QUALITY ASSURANCE

A. NEMA PB-1, Panelboards

B. NEC

C. UL67, Panelboards

PART 2 - PRODUCTS

2.1 PANELBOARDS

A. Dead-front panelboards, including lighting distribution and control panels, shall be furnished and installed as indicated on the Plans. Buses shall be tin-plated copper. If shown on the drawings as 4 wire, neutral shall be 100% rated. Mounting and type of enclosures shall be as indicated on the Plans. Where not indicated, indoor enclosures shall be NEMA 12 and outdoor enclosures shall be NEMA 4. The minimum interrupting capacity of any device shall be 22 KAIC unless otherwise indicated on the Plans.

B. All lighting panels shall have surge protection devices.

C. Protective devices shall be replaceable without disturbing adjacent units and shall be of the bolt-on type. Snap in protective devices will not be accepted. Wire connectors shall be suitable for wire sizes indicated. Branch circuits shall be numbered as indicated on the Plans, and a complete typed circuit schedule shall be furnished under a transparent cover and affixed to the inside of the panel access door. Phase busing shall be full height without reduction. Full size neutral and ground bars shall be included and shall have suitable lugs for each outgoing circuit requiring connection. Spaces for future protective devices provided in lighting panels shall be bused for the maximum device that can be fitted into them.

D. Panelboards shall be finished with a primer, rust resistant phosphate undercoat and two coats of oven baked enamel with finish ANSI grey. They shall be sized to provide a minimum of 4 inches of gutter space on all sides. Doors shall not uncover any live parts and shall be hinged

and have latches that require no tool to operate. Panelboard doors shall be lockable. Lock and two keys shall be furnished.

E. Each panelboard shall have, on the outside of the door, a lamicoid nameplate with ¾-inch letters as specified elsewhere in these Contract Documents.

F. Panelboards shall be as manufactured by Square D, General Electric, Eaton / Cutler Hammer, or equal.

G. Panelboards shall be service entrance rated where required, and as shown on the Plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Panelboards shall be installed as indicated on the plans and according to manufacturer's instructions.

B. Provide grounding per NEC, and Section 260526.

C. Contractor shall verify all NEC clearance requirements prior to installation.

END OF SECTION 262416

SECTION 262419 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall furnish and install, ready to use, motor control centers for use as indicated on the Contract Drawings and specified herein.

B. Circuit breaker ratings, and modifications, shall be as indicated on the Contract Drawings.

C. MCP ratings, and modification, shall be as indicated on the Contract Drawings.

1.2 SUBMITTALS

A. The motor control centers shall meet the requirements of the latest edition of Standards for Industrial Control No. ICS published by the National Electrical Manufacturers Association. The following minimum information and drawings shall be submitted for review:

1. Plan, front, side views and overall dimension of each motor control center.
2. Weight.
3. Internal wiring diagram of each plug-in unit.
4. Internal wiring diagram of the motor control centers.
5. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
6. One-line and schematic diagram for each motor control center.
7. Bill of material list and Manufacturer's Product Data.
8. Installation instructions including seismic installation.
9. Manufacturer's certification that the following items are capable of interrupting and/or withstanding the specified short circuit condition:
    a. Bus bar bracing
    b. Feeder tap units
    c. Starter units

B. Product information shall be submitted in accordance with Section 26 00 00 “General Electrical Requirements”, and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.1 MOTOR CONTROL CENTERS (MCC)

A. The motor control center fabricator shall be the manufacturer of the major components therein, such as circuit breakers and starters. Engineered motor control centers shall be by the component and housing manufacturer. The manufacturer shall comply with equipment specifications contained elsewhere in these Contract Documents.

B. Each component, as well as the complete assembly, shall be constructed and tested in accordance with latest NEMA Standards for Industrial Control. The type of construction of

the control centers shall be NEMA Class II, Type B. Lifting eyes shall be provided on each section to facilitate handling.

C. Unit doors shall be mounted on the stationary structure and hinged on the side away from the vertical wireway. They shall be held closed with slotted thumbscrews.

D. Unit doors shall have positive action linkage with disconnect operating mechanism. Mechanism shall be designed so that it can be locked in the OFF position with up to 3 padlocks. When the handle is not padlocked, it shall be possible to open the door by releasing the door interlock with a small screwdriver. The control units shall be of the plug-in type. When doors are closed, the operating mechanism shall clearly indicate the ON or OFF position of the disconnect, and the door interlock mechanism shall engage. The disconnect operating mechanism shall be designed against inadvertent operation when the door is open. Each plug-in unit door shall be provided with a nameplate, specified elsewhere herein, that indicates the circuit number and circuit name. The nameplate shall be attached to the door with stainless steel screws. Each motor starter door shall be provided with an externally operated manual reset pushbutton for the overload relay.

E. It shall be possible to install up to 6 NEMA size one units in one vertical section. Units shall be completely enclosed with sheet steel. A small wireway shall be provided inside the unit, so all wiring can be laid in place without removing barriers or plates. Each vertical section that holds the units shall be rigidly formed of minimum 12 gauge, cold-rolled sheet steel. The vertical front-of-board-construction shall be supplied with minimum 20-inch depth.

F. Continuous horizontal wiring troughs shall be provided at both top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the MCC. A large continuous, full-height vertical wiring trough shall be provided in the right side of each section.

G. All starter wiring, control, and power shall be terminated in terminal strips in this trough for size 2 and smaller starters. Size 3 and larger starters shall have control leads terminating on the terminal strips in the trough. Terminal strips shall be split-type to facilitate wiring connections without disconnecting factory or field conductors. Terminal strips shall be rated to accept conductor sizes as indicated on the Contract Drawings.

H. All bus bars shall be tin plated copper and shall be of the ampacity indicated on the Contract Drawings. Unit bus bar stabs shall insure high contact pressure. The vertical bus bars shall be effectively isolated from accidental contact by plastic insulating medium.

I. Bus bar supports shall be of high impact strength non-carbonizing insulating material mounted on padded steel brackets and shall provide adequate dielectric strength and creepage distance. The bus structure shall be capable of withstanding short circuit current in accordance with NEMA standards, and as indicated on the Contract Drawings.

J. Each section shall be equipped with horizontal ground bus that shall be continuous across the MCC.

K. The MCCs shall be supplied as indicated on the Contract Drawings, and as specified herein and in accordance with NEMA Standard Pub. IS 1.1, latest edition. The MCCs shall be enclosed in NEMA Type 1 gasketed industrial use enclosures, unless otherwise shown.

NEMA 3R enclosures shall provide sufficient depth for air conditioning units to be mounted on the end of the structures. If the MCCs contain VFDs or Solid-State Starters that require cooling, their respective sections shall be louvered top and bottom, and fans shall remove heat from within the sections.

L. All metal surfaces and structural parts shall be given a phosphatizing, or equal, treatment prior to painting. The control centers shall then be given a gun-metal gray undercoat which is equal to zinc chromate. The exterior of the enclosure shall be finished in standard ANSI Grey.

M. Spaces for future combination starters shall have all the hardware necessary so that a future plug-in control unit can be installed without having to modify the vertical sections. The number of spaces for future control units shall be as indicated on the Contract Drawings.

N. Devices, such as, but not limited to, starters, circuit breaker, relays, timers, conductors, shall conform to other sections of these Contract Documents.

O. Provide customer metering instruments, as indicated on the Contract Drawings. Unless otherwise indicated on the Contract Drawings, metering units shall be electronic, capable of displaying volts line-to-line and line-to-neutral, and amps per phase.

P. Each section shall be equipped with horizontal neutral bus that shall be continuous across the MCC if the MCC is designated as 277/480-volt 4 wire.

Q. MCCs for this project shall be an intelligent MCC assembly with smart starters and VFD's each with an Ethernet port and support for monitoring and control over the Ethernet/IP protocol. Due to the variance in methods for implementing smart starters and VFDs, the schematics shown in the Contract Drawings shall be used as a guide in developing the actual schematics based upon actual vendor information. Each intelligent MCC shall be equipped with Layer 2 managed switches powered by a redundant DC power supply system. The connection from the plant SCADA network to the MCC shall be from a single CAT6 connection. Provide a minimum of four spare copper Ethernet ports for future connections.

Q. MCCs shall be as manufactured by Allen-Bradley, Eaton or Square D.

PART 3 - EXECUTION

3.1 GENERAL

A. The MCCs shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.

B. Cables larger than No. 6 AWG, which hang from their vertical connections, shall be supported within 2 feet of the connection.

C. The motor overload relays shall be provided and sized based on the actual full load amperes of the motor connected to the starter.

D. The motor circuit protectors shall be adjusted to the lowest settings that do not cause false tripping.

E. Motor control centers shall be installed for seismic requirements as required in division 260000 “General Electrical Requirements”.

F. Motor Control Centers shall be provided in accordance with all applicable sections of division 260000.

3.2 FIELD TESTS

A. MCCs shall be tested in accordance with Section 260000.

END OF SECTION 262419

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch and exterior occupancy sensors.
6. Communications outlets.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Appleton Electric Co. (Appleton).
2. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
3. Cooper Crouse-Hinds (Crouse-Hinds).
4. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
5. Killark.
6. Leviton Mfg. Company Inc. (Leviton).
7. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES FOR UNCLASSIFIED AREAS

A. General Description

1. Convenience Receptacles, 125 V, 20 A
2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
3. Straight blade, grounding type, specification grade.
4. Color: White unless Owner or Engineer specifies otherwise. Ivory for weather resistant receptacles. Yellow for corrosion resistant receptacles.
5. Provide weather resistant receptacles for damp and wet areas (including all process areas or areas that may be sprayed down).
6. Provide corrosion resistant receptacles for corrosive areas.

B. Products: Subject to compliance with requirements, provide the following:

1. Dry, non-corrosive locations:
   a. Hubbell; HBL5361 (single), HBL5362 (duplex).
   b. Or Approved Equal.
2. Damp or wet locations:
   a. Hubbell; HBL5361WR (single), HBL5362WR (duplex).
   b. Or Approved Equal.
3. Corrosive locations:
   a. Hubbell; HBL53CM61 (single), HBL53CM62 (duplex).
   b. Or Approved Equal.

2.4 RECEPTACLES FOR CLASSIFIED AREAS

A. General Description

1. Explosion proof, UL Listed for Class 1 Division I and II Groups C & D
2. Rated for 125 V, 20 A
3. Corrosion Resistant with malleable iron mounting box.
4. “Dead-front” construction requiring plug to be inserted and rotated to activate receptacle.
5. Factory Sealed so that seal-offs are not required at the receptacle.
6. If receptacles are to have GFCI, this shall be achieved at the branch circuit overcurrent protective device (typically a lighting panel) in an unclassified space.

B. Products: Subject to compliance with requirements, provide the following:

1. Appleton U-Line Contender series.
2. Crouse-Hinds Arktite Series.
3. Or Approved Equal.

2.5 GFCI RECEPTACLES FOR UNCLASSIFIED AREAS

A. General Description:

1. Duplex GFCI Convenience Receptacles, 125 V, 20 A.
2. Straight blade, feed-through type.
3. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
4. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
5. Receptacles shall be tamper and weather resistant.

B. Products: Subject to compliance with requirements, provide the following:

1. Hubbell; GFR5362TR.
2. Or Approved Equal.

2.6 TOGGLE SWITCHES FOR UNCLASSIFIED AREAS

A. General Description:

1. Toggle Switches, 120/277 V, 20A
2. Comply with NEMA WD 1, UL 20, and FS W-S-896.
3. Toggle type, quiet action, specification grade with grounding terminal.
4. Back and side wired, silver alloy contacts.
5. Color: White unless Owner or Engineer specifies otherwise.
6. For corrosive or wet areas, provide a NEMA 4X watertight, dust-tight and corrosion resistant cover.

B. Switches:

1. Products: Subject to compliance with requirements, provide the following:

a. Switches, 120/277 V, 20 A:
   1) Hubbell; HBL1221 (Single Pole); HBL1222 (Double Pole); HBL1223 (Three Way); HBL1224 (Four Way).
   2) Or Approved Equal.

b. Illuminated Switches (illuminated when switch is “off”:
   1) Hubbell; HBL1221IL (Single Pole); HBL1223IL (Three Way).
   2) Or Approved Equal.

c. Key-Operated Switches (with factory supplied key):
   1) Hubbell; HBL1221L
   2) Or Approved Equal.

2.7 TOGGLE SWITCHES FOR CLASSIFIED AREAS

A. General Description:

1. Explosion proof, UL Listed for Class 1 Division I and II Groups C & D
2. Rated for 125 V, 20 A
3. Corrosion Resistant with malleable iron body and cover.
4. Factory Sealed so that seal-offs are not required at the receptacle.
5. Front operated handle with stainless steel shaft.
6. With grounding screw.

B. Products: Subject to compliance with requirements, provide the following:

1. Appleton Contender series.
2. Crouse-Hinds EDS Series.
3. Or Approved Equal.

2.8 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off." Load shall not exceed 80% of dimmer rating.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish except for stainless steel wall plates whose screws shall be stainless steel.
2. Material for Finished Office Spaces: Smooth, high-impact thermoplastic, color to match device color.
3. Material for Finished Spaces: Type 304 stainless steel.
4. Material for Unfinished Spaces: Type 304 stainless steel.
5. Material for Damp and corrosive Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant**,** die-cast aluminum with lockable cover.

C. Weatherproof, While-In-Use Covers: Where receptacles are required to be weatherproof and physically protected while in use or idle or where shown on the drawings, weatherproof, while-in-use covers shall be used in lieu of other covers. The cover shall have the following features:

1. General Description:

a. Suitable style receptacle plate with a hinged cover.
b. Cord port(s) capable of allowing an appropriate size electrical cord(s) to pass through when the cover is closed.
c. Latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant (locking/security) style in areas where security is needed.
d. Sufficiently deep to allow full closure with plug(s) in use.
e. UL listed per UL Standard 514C and conform to NEC Article 410.57 paragraphs a and b, Article 110.3 and Article 110.11.
f. Body materials shall be of a flame resistant, self-extinguishing, UV inhibiting, impact resistant, polycarbonate resin. Materials must meet UL Standard 94 HF1.
g. Mounting screws shall be stainless steel and of sufficient length to properly secure the device and ensure seal to mounting surface.

2. Products: Subject to compliance with requirements, provide the following:

a. Cooper; TP74 Series.
b. Or Approved Equal.

2.10 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless Owner or Engineer specifies otherwise or otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to UPS or Emergency Power System: Red.
3. TVSS Devices: Blue.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Wherever possible, wiring devices shall be recess mounted with switches, receptacles and wall plates flush with the wall or surface.
2. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
3. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
4. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
5. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
6. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
7. Use a torque screwdriver when a torque is recommended or required by manufacturer.

8. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
9. Tighten unused terminal screws on the device.
10. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.
2. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.
3. Set switches and receptacles plumb and vertical to the floor.
4. Set recess-mounted switches and receptacles flush with face of walls.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening. Provide blank plates for empty boxes.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
4. Do not connect dimmers to loads in excess of 80% of the rating of the dimmer.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262816 – ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Manual Transfer Switches
2. Generator Connection Enclosures

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches shall withstand the effects of earthquake motions determined according to ASCE.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUAL TRANSFER SWITCHES

A. The manual transfer switch shall be open transition, break-before-make type double throw safety switch. The manual transfer switch shall be heavy duty with a quick make, quick break operating mechanism, with full cover interlock, and indicator handle.

B. The switch shall be rated for the voltage and current and shall have the number of poles indicated on the Plans. Lugs shall be able to accommodate up to 600MCM cabling.

C. The transfer switch shall be listed by UL.

D. Enclosures shall be rated NEMA 12 for indoor use, and NEMA 3R for outdoor use, unless otherwise indicated on the Plans.

E. The manual transfer switch handle shall be padlockable.

F. Manual transfer switches shall be as manufactured by Square D, Eaton, Allen-Bradley, or approved equal.

2.2 GENERATOR CONNECTION ENCLOSURES

A. Provide a 480V, 3-Phase 3-Wire 600A, NEMA 3R enclosure fabricated from galvanized steel and power coated ANSI gray. The enclosure shall have mounting tabs for surface mounting and a drip shield above the door opening. The enclosure shall have a hinged front door provided with a latch that is padlockable.

B. The bottom of the enclosure shall contain a hinged door for the entry of portable cable. The door shall be secured by a latch accessible only from the inside of the enclosure.

C. The conduit entrance shall be through the back, sides or bottom of the enclosure. Wire terminations for the building wire shall be to mechanical lugs sized for 600A and large enough to accommodate up to 600MCM cabling.

D. A dead front cover shall prevent access to the internal electrical components when the main access door is open.

E. Series 16 Cam inlets shall be mounted on an internal dead front inlet panel and shall accept standard E1016 type connectors. One set of cam inlets rated for up to 400A shall be provided. Cam inlets shall be color coded for phase (brown, orange and yellow) and ground (green).

F. The ground inlet shall be wired to the enclosure frame and a ground connection lug shall be provided for contractor termination of the building ground wire.

G. The internal dead front inlet panel shall contain slots between inlets to eliminate hysteresis, as required by the NEC.

H. A warning label to specify the proper sequence for connection and removal of portable cable as shall be mechanically fastened to front cover of the enclosure.

I. The Generator Connection Box shall meet or exceed all applicable NEC standards and shall be UL Listed. A label denoting the UL Listing shall be permanently affixed to the unit.

J. Generator connection enclosures shall be as manufactured by Union Connector, Lex, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Enclosed switches and generator connection enclosures shall be installed, in accordance with the manufacturers' recommendations.

B. The enclosed switches and generator connection enclosures shall be installed as indicated on the Plans.

C. Provide grounding per NEC.

END OF SECTION 262816

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SECTION 262819 – DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section covers electrical disconnecting switches.

1.2 SUBMITTALS

A. Products shall be submitted in accordance with Section 260000, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy-duty safety switches with a quick-make, quick-break operating mechanism, with full cover interlock, and indicator handle.

B. Where specified as fused disconnect switches, disconnects shall be furnished with fuses of the size indicated on the Plans. One set of spare fuses shall be furnished for each fused disconnect switch.

C. Disconnect switches shall be NEMA type HD heavy duty construction, UL 98 listed.

D. Enclosures shall be rated NEMA 12 for indoor use, and NEMA 3R for outdoor use, unless otherwise indicated on the Plans.

E. Disconnect switch handle shall be padlockable.

F. Disconnect switches in damp, wet or corrosive areas as indicated on the Plans, shall be NEMA 4X, 304 stainless steel. All disconnect switches in wastewater applications shall be NEMA 4X unless otherwise noted on the plans.

G. Disconnect switches located in hazardous locations shall be rated NEMA 7.

H. Disconnect switches shall be as manufactured by one of the following:
1. Square D
2. Cutler-Hammer
3. Or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Disconnect switches shall be installed as indicated on the Plans.

B. Provide grounding per NEC, and Section 260526.

END OF SECTION 262819

SECTION 262923 - VARIABLE-FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. See Section 26 24 19 "Motor-Control Centers" for VFDs installed in motor-control centers.

1.2 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).
B. CPT: Control power transformer.
C. EMI: Electromagnetic interference.
D. IGBT: Insulated-gate bipolar transistor.
E. LAN: Local area network.
F. LED: Light-emitting diode.
G. MCP: Motor-circuit protector.
H. NC: Normally closed.
I. NO: Normally open.
J. OCPD: Overcurrent protective device.
K. PCC: Point of Common Coupling
L. PID: Control action, proportional plus integral plus derivative.
M. PWM: Pulse-width modulated.
N. P&ID: Process & Instrumentation Diagram
O. RFI: Radio-frequency interference.
P. SCADA: Supervisory control and data acquisition.
Q. TDD: Total Demand Distortion
R. THD: Total Harmonic Distortion
S. VFD: Variable-frequency drive.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFDs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFD indicated.

B. System Harmonics Analysis: For each VFD and for the distribution system as a whole.

C. Shop Drawings: For each VFD indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings.
2. Schematic and Connection Wiring Diagrams: For power, signal, communications, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Seismic Qualification Certificates: For VFDs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

C. Product certificates.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. IEEE Compliance: Fabricate and test VFD according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Schneider Electric, Inc.; Altivar Process 630 series drives.
2. Eaton SVX/SPX9000 series drives.
3. Or Approved Equal

B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Constant torque and variable torque.

D. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 200 (60 as programmed default) Hz, programmable as voltage proportional to frequency throughout voltage range or with sensorless vector control; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.

4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: Equal to the rating of the gear feeding the drive. If not listed, 65 kA.
7. Ambient Temperature Rating: Not less than 14 deg F (minus 10 deg C) and not exceeding 122 deg F (50 deg C). This is specifically the requirement for the VFD unit itself and not the overall panel assembly. The overall assembly shall meet the requirements of 260000-1.4-A-8 which requires the overall assembly to operate at an ambient temperature of up to 104°F. Electrical equipment not rated for operation at that temperature shall be provided with air conditioning. The majority of the MCC's for the project are located indoors in air-conditioned rooms which satisfies this requirement. VFD assemblies shall have appropriately designed ventilation and or air conditioning so as to protect the internal components and to keep internal panel temperatures below the internal components' rated temperatures.
8. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 158 deg F (70 deg C)
9. Humidity Rating: Less than 95 percent (noncondensing).
10. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: VFD system shall be rated for continuous operation at a minimum of 110% of motor load full load amps (FLA) times the motor service factor. Variable torque inverters shall be capable of delivering 110% of continuous rating for a minimum of 60 seconds. Constant torque inverters shall be capable of delivering 150% of continuous rating for a minimum of 60 seconds.
13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
14. Speed Regulation: Plus or minus 0.6 Hz.
15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, VFD isolated from all power circuits.

I. Isolated Control Interface: Allows VFDs to follow remote-control electrical signal over a minimum 100:1 speed range.

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.

4. Inverter overcurrent trips.
5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

N. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFD input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. VFD Fault.
4. All other lights as shown on the design drawings.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

C. Historical Logging Information and Displays:

1. Running log of total power versus time.
2. Total run time.
3. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

a. Speed Reference: The VFD drive shall be capable of being controlled locally by a speed potentiometer or remotely by a 4- to 20-mA dc signal. The 4- to 20-mA signal shall be galvanically isolated and input resistance shall not exceed 250 ohms.

b. A minimum of two programmable analog inputs shall be provided and would be typically used for PID process variables and set point. These signals shall be set up to accept a 4- to 20-mA dc signal. The 4- to 20-mA signal shall be galvanically isolated and input resistance shall not exceed 250 ohms.

c. A minimum of six multifunction programmable digital inputs. The drive shall be expandable to handle additional digital inputs if required. The digital inputs shall be programmable to perform functions including, but not limited to:

1) VFD Start/Stop Control (2 or 3 wire)
2) Forward/Reverse/Stop Control
3) Local/Remote. The VFD shall be programmable so that "Local" control may either be the keypad or by hard-wired start/stop and potentiometer. The VFD shall be programmable so that "Remote" control may either be hard-wired start/stop and 4- to 20mA speed control or via the communications network.
4) VFD Interlock/Enable. This input when de-energized will not allow the VFD to run the motor under any circumstance.
5) VFD External Fault. This input will trip the VFD and require a reset before allowing the motor to run again.
6) Preset Frequencies. The VFD shall be programmable to run at pre-programmed frequencies with up to 6 different steps.

2. Output Signal Interface:

a. A minimum of two programmable analog output signals 4- to 20-mA dc, which can be configured for any of the following:

1) Output frequency (Hz).
2) Output current (load).
3) DC-link voltage (V dc).
4) Motor torque (percent).
5) Motor speed (rpm).
6) Set point frequency (Hz).
7) Motor power (kW)

b. A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following (the drive shall be expandable to handle additional digital outputs if required):

1) Motor running.
2) VFD ready.
3) Set point speed reached.
4) Fault and warning indication (overtemperature or overcurrent).
5) PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

G. SCADA Interface: Factory-installed hardware and software to enable the SCADA to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: Ethernet
2. SCADA Protocols for Network Communications: Modbus TCP protocol accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: All new power distribution systems supplied shall be required to meet the requirements of IEEE 519-1992. Specifically, the system shall adhere to the TDD requirements of Table 10-3 of IEEE 519-1992. If the power distribution system is equipped with an Active Harmonic System, each VFD shall be equipped with a line reactor whose impedance is as recommended by the Active Harmonic System manufacturer (typically 3%). If no Active Harmonic System is part of the power distribution system, the following rules as a minimum shall define the input line conditioning for each VFD (unless further conditioning is required to meet the IEEE 519-1992 limits). With the Engineer’s approval, the contractor may decide to supply an Active Harmonic System even if not shown on the drawings, with corresponding reactors and chokes (this would typically occur if it is more cost effective to meet IEEE 519 with a single system then multiple harmonic filters).

1. All VFD's sized for motors 50HP or larger shall be equipped with DC-link chokes.
2. All VFD's sized for motors 40HP and less shall be equipped with 5%-line reactors unless specifically called out as otherwise on the drawings.
3. All VFD's sized for 50HP to 200HP motors shall be equipped with passive harmonic filters with DC Link Chokes.
4. All VFD's greater than 200HP shall have been setup to have less than 5% THD for both voltage and current. This would typically require that the drive is setup with an 18-pulse front end or with an active harmonic filter. The VFD assembly shall accept a single 3-phase input and shall contain all of the harmonic mitigation equipment as part of the assembly.

B. EMI/RFI Filtering: VFD's shall be CE marked and certify compliance with IEC 61800-3 for Category C2.

2.4 LOAD CONDITIONING

A. Load Conditioning: For VFD driven loads with conductor lengths between 200 and 1,000 feet, output dV/dt filters shall be provided as part of the VFD assembly. It is strongly recommended that VFD motor leads not be longer than 500 feet and alternative VFD locations should be considered. If absolutely necessary, loads with conductor lengths greater than 1,000 feet shall have output sine wave filters shall be provided as part of the VFD assembly. Voltage drop considerations shall be taken into account when selecting the motor's nameplate voltage.

2.5 LINE AND LOAD CONDITIONING EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. MTE Corporation.
2. Transcoil International (TCI).
3. Or approved equal.

B. Line Reactors: Reactors shall be part of the VFD assembly. They shall be sized based upon the VFD input power requirements. They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The reactor shall meet the following criteria:

1. The reactor shall be UL 508 listed.
2. Continuous current rating: 100% RMS.
3. Intermittent current ratings: 150% for 60 seconds; 200% for 10 seconds.
4. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
5. All wiring shall be copper.

C. Passive Harmonic Filters: Filters shall be part of the VFD assembly. They shall be sized based upon the VFD input power requirements. They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:

1. The filter shall be UL 508 listed.

2. The filter shall filter harmonics generated by the nonlinear VFD to satisfy the requirements of IEEE 519-1992 for individual and total harmonic voltage and current distortion at the input terminals of the filter.
3. The TDD of the current at the input terminals of the filter shall not exceed the limits defined in Table 10-3 of IEEE 519-1992.
4. Full load efficiency: 97% or greater
5. The filter shall not resonate with the power distribution system nor attract harmonics from other sources.
6. The harmonic filter shall be a passive series connected low pass filter consisting of an inductor capacitor network. Active electronic components shall not be used.
7. The harmonic filter shall be equipped with a contactor that will connect the capacitor(s) only when the motor is running, avoiding nuisance VFD over-voltage tripping.
8. All wiring shall be copper.

D. dV/dt Filters: Filters shall be part of the VFD assembly. They shall be sized based upon motor horsepower and required full-load current (including service factor). They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:

1. The filter shall be UL 508 listed.
2. Maximum peak motor terminal voltage with 500 feet of cable: 15% of bus voltage.
3. Maximum dV/dt: 200 Volts per microsecond.
4. The dV/dt Filter shall reduce common mode voltages by a minimum of 40%.
5. Continuous current rating: 100% RMS.
6. Intermittent current ratings: 150% for 60 seconds; 200% for 10 seconds.
7. Allowed inverter switching frequencies: 1kHz to 8 kHz.
8. Nominal inverter operating frequency: 60Hz; Minimum – 6 Hz; Maximum with de-rating: 120Hz.
9. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
10. Insertion loss: 3% of rated voltage maximum.
11. All wiring shall be copper.

E. Sine Wave Filters: Filters shall be part of the VFD assembly. They shall be sized based upon motor horsepower and required full-load current (including service factor). They shall be properly installed with appropriate spacing and ventilation for ambient temperatures up to 104°F. The filter shall meet the following criteria:

1. The filter shall be UL 508 listed.
2. Harmonic Voltage Distortion: 10% maximum
3. Continuous current rating: 100% RMS.
4. Intermittent current rating: 150% for 60 seconds.
5. Allowed inverter switching frequencies: 2kHz to 8 kHz.
6. Nominal inverter operating frequency: 60Hz; Minimum – 0 Hz; Maximum with de-rating: 90Hz.
7. The Sine Wave Filter shall reduce common mode voltages by a minimum of 40%.
8. Altitude Rating: Not exceeding 3300 feet without de-rating. Up to 9850 feet with de-rating.
9. Insertion loss: 6% of rated voltage maximum.
10. All wiring shall be copper.

2.6 BYPASS SYSTEMS

A. Provide Bypass Systems only if indicated on the drawings.

B. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

D. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

E. Bypass Contactor Configuration: Full-voltage (across-the-line) or reduced voltage soft-starter as shown on the drawings.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

    a. CPT Spare Capacity: 100 VA.

6. Overload Relays: NEMA ICS 2.

2.7 ENCLOSURES

A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry, Clean and Non-corrosive Indoor Locations: Type 1.
2. Outdoor or Corrosive Locations: Type 4X, stainless steel.
3. Wash-Down Areas: Type 4X, stainless steel.
4. Other Wet or Damp Indoor Locations: Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.8 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.

a. Push Buttons: Maintained and/or momentary as required.
b. Pilot Lights: LED types; colors as shown on P&ID's; push to test.
c. Selector Switches: Rotary type.

B. Bypass contactor auxiliary contact(s) as required.

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Analog Meters:

1. Elapsed time meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4, 4X, and 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4, 4X, 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, maintaining enclosure NEMA rating; UL 508 component recognized: Supply fan, with non-corrosive intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.

I. Air Conditioning System: For NEMA 250, maintaining enclosure NEMA rating; UL 508 component recognized; sized to maintain internal temperatures at or below 100°F.

2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to its specified motor.
2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFD.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

3.2 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation.
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

9. Perform voltage and current harmonic test with each VFD running at minimum and maximum speed. Submit test results for each VFD. Testing shall be witnessed by the Owner and the Engineer.

E. VFDs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs. A minimum of 4 hours of training shall be provided. The training shall cover VFD theory of operation, features and functions available, normal operation, troubleshooting, and routine maintenance. The Contractor shall submit a syllabus for the training session for approval, within 3 weeks of conducting the class. Provide each attendee with a class syllabus detailing each topic to be discussed.

3.7 SPARE PARTS

A. The following spare parts shall be supplied with each type, or frame size, of VFD:
   1. 3 sets of all replaceable fuses
   2. 3 spare air conditioner or fan filters

END OF DOCUMENT

SECTION 263213 – ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. General: The CONTRACTOR shall provide a factory assembled standby diesel electric generator system complete and operable with digital electronic controls, in conformance to the Contract Documents.

B. The provisions of this Section apply to standby diesel electric generators throughout the Contract Documents, except as indicated otherwise.

C. Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system.

D. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator set.

E. The CONTRACTOR shall be responsible for obtaining any required air quality permits on behalf of the OWNER, posting all public notices, and shall include all associated fees in their bid, listed as separate line items in the schedule of values. The generator vendor shall provide the Contractor with the documentation required for permitting, showing published proof of EPA certification on the engine specified and furnished herein.

1.2 CODES AND STANDARDS

A. The generator set and its installation and on-site testing shall conform to the requirements of the following codes and standards:

1. CSA C22.2, No. 14 – M91 Industrial Control Equipment
2. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
3. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
4. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
5. FCC Part 15, Subpart B.
6. IEC8528 part 4. Control Systems for Generator Sets.
7. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
8. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
9. IEEE587 for voltage surge resistance.
10. Mil Std 461D –1993. Military Standard, Electromagnetic Interference Characteristics.
11. Mil Std 462D - 1993. Military Standard, Measurement of Electromagnetic Interference Characteristics.
12. NEMA ICS10-1993 – AC Generator sets.
13. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702

14. NFPA99 – Essential Electrical Systems for Health Care Facilities.
15. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement
16. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
17. UL2200. The generator set shall be listed to UL2200 or submit to an independent third-party certification process to verify compliance as installed.

B. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.3 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kohler Power Systems; Generator Division.
b. Onan/Cummins Power Generation; Industrial Business Group.
c. Caterpillar; Engine Div.

1.4 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013000 - Contractor Submittals.

B. Submit shop drawings containing actual dimensions, complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Shop drawings shall show proposed layout, anchoring, support and appurtenances, including clearances for maintenance and operations. Shop drawings shall show details of piping connections for fuel.

C. Submit a complete list of equipment and material, including manufacturer's specifications, performance charts, catalog cuts and installation instructions, and recommended spare parts list. Submit data for each different item of equipment specified, including but not limited to engine, generator, switchgear, automatic transfer switch, vibration isolators, radiator, and other components. The data shall include a complete list of parts and source of supply.

D. Submit performance test reports in booklet form showing all field tests, and adjustments performed to prove compliance with specified criteria.

E. Operation and maintenance (O&M) manuals shall describe the step-by-step procedure required for system start-up, operation and routine maintenance. The O&M manuals shall include troubleshooting and repair guidelines, as well as wiring diagrams of the system as installed.

F. Miscellaneous:

1. Dimensions, dry and wet weight.
2. Manufacturer’s kilowatts output curve and fuel consumption.

3. Manufacturer's transient response data of the complete engine generator set upon 50%, 75%, and 100% block loads at 1.0 pf. Data shall include maximum voltage dips, maximum frequency dips, and recovery time periods.
4. Engine altitude duration curve
5. Generator motor starting curves showing the voltage dips versus starting KVA.
6. Prototype test certifications showing all components comply with specifications.

G. The following spare parts for the engine generator shall be supplied to the OWNER prior to acceptance of work: Two sets of oil filters, two sets of heavy-duty air filters, one dozen spare lamps, two fuses (for each control circuit).

1. Two set of oil filters.
2. Two sets of heavy-duty air filters
3. One dozen spare lamps
4. Fuses (for each control circuit)

PART 2 -- PRODUCTS

2.1 ENGINE GENERATOR SET

A. Requirements

1. All materials, equipment, and parts comprising the units specified herein, shall be new and unused, and of the highest grade.

2. The engine, generator and all major items of auxiliary equipment shall be manufactured by manufacturers currently engaged in the production of such equipment. The unit shall be factory assembled and tested by the engine SUPPLIER and shipped to the job site by his authorized dealer having a parts and service facility in the area. The performance of the electric plant shall be certified by SUPPLIER as to the plant's full power rating, stability and voltage and frequency regulation, and field load tested at site.

3. The units offered under these Contract Documents shall be covered by the SUPPLIER's standard warranty, or guarantee, on new machines, and shall be a minimum of two years after the date of substantial completion.

B. Ratings

1. The generator set shall operate at 1800 rpm and at a voltage of: 480 Volts AC, Three phase, Four-wire, 60 hertz.

2. The generator set shall be rated at as indicated on the drawings,~~1250 kW, 1563 kVA~~ at 0.8 PF, after de-rating, based on site conditions of: Altitude 4300 ft. (1300 meters), ambient temperatures up to 122 degrees F (50 degrees C). The~~ 1250 kW~~ sizing is an ~~approximation~~approximation, and it is the supplier's responsibility to properly size the generator based upon the following steps (include capacity for 20% additional future expansion):

~~a. Step 1 – Auxiliary Power – Estimated Load is 30kW~~

~~b. Step 2 – Well Pump (soft starter driven) – 350 HP~~

~~c. Step 3 – Reclaim Pump (across the line) – 15 HP~~

3. The generator set rating shall be based on emergency/standby service.

C. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.

2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.

3. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

4. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.

5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.

D. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.

2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

E. Connections

1. The generator set load connections shall be composed of tin-plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.

2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.

3. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.2 ENGINE AND ENGINE EQUIPMENT

A. The engine shall be diesel, 4 cycle, radiator and fan cooled with 6 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:

B. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.

C. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H_2O external static head. Radiator shall be sized based on a core temperature which is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment SUPPLIER. Rotating parts shall be guarded against accidental contact.

D. Electric starter(s) capable of three complete cranking cycles without overheating.

E. Positive displacement, mechanical, full pressure, lubrication oil pump.

F. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

G. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator se at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.

H. Replaceable dry element air cleaner with restriction indicator.

I. Flexible supply and return fuel lines.

J. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.

K. Fuel return pump shall be provided where an external fuel system is utilized. Generator manufacturer to coordinate with Fuel tank supplier to ensure size of pump and control for pump are coordinated and function properly.

L. Coolant heater.

1. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.

2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

3. The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.

4. The coolant heater(s) shall be sized as recommended by the engine SUPPLIER to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with

NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

M. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set SUPPLIER. Isolators shall include seismic restraints if required by site location.

N. Starting and Control Batteries shall be calcium/lead antimony type, 24-volt DC, sized as recommended by the engine SUPPLIER, complete with battery cables and connectors.

O. Provide an exhaust silencer for each engine of size and type as recommended by the generator set SUPPLIER and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.

P. A UL listed/CSA certified 10-amp voltage regulated battery charger shall be provided for each engine-generator set. The charger may be located in an automatic transfer switch, or may be wall mounted, at the discretion of the installer. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:

1. Loss of AC power - red light
2. Low battery voltage - red light
3. High battery voltage - red light
4. Power ON - green light (no relay contact)
5. Charger shall include an Analog DC voltmeter and ammeter, 12-hour equalize charge timer, and AC and DC fuses

Q. Provide a dual wall sub-base fuel storage tank with 24 hours of capacity at full load. The tank shall be constructed of corrosion resistant steel and shall be UL listed. The equipment, as installed, shall meet all local and regional requirements for above ground tanks.

2.3 GENERATOR

A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.

B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

D. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

2.4 GENERATOR SET CONTROL

A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

B. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

C. The generator set mounted control shall include the following switches:

1. MODE SELECT switch. The mode select switch shall initiate the following control modes. When in the RUN or Manual position the generator set shall start and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.

2. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down and be locked out from automatic restarting.

3. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

4. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

D. The generator set mounted control shall include the following AC Output Metering with the following features and functions:

1. Analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.

2. Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages and shall display all three phase voltages (line to neutral or line to line) simultaneously.

3. Both analog and digital metering are required. The analog and digital metering equipment shall be driven by a single microprocessor, to provide consistent readings and performance.

E. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright

room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel.

1. Low Oil Pressure (alarm).
2. Low Oil Pressure (shutdown).
3. Oil Pressure Sender Failure (alarm).
4. Low Coolant Temperature (alarm).
5. High Coolant Temperature (alarm).
6. High Coolant Temperature (shutdown).
7. Engine Temperature Sender Failure (alarm).
8. Low Coolant Level (alarm or shutdown—selectable)
9. Fail to Crank (shutdown)
10. Fail to Start/Overcrank (shutdown)
11. Overspeed (shutdown)
12. Low DC Voltage (alarm)
13. High DC Voltage (alarm)
14. Weak Battery (alarm)
15. Low Fuel-Daytank (alarm)
16. High AC Voltage (shutdown)
17. Low AC Voltage (shutdown)
18. Under Frequency (shutdown)
19. Over Current (warning)
20. Over Current (shutdown)
21. Short Circuit (shutdown)
22. Over Load (alarm)
23. Emergency Stop (shutdown)
24. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

F. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

G. The generator set mounted control shall include the following engine status monitoring:

1. Engine Oil Pressure (psi or kPA)
2. Engine Coolant Temperature (degrees F or C)
3. Engine Oil Temperature (degrees F or C)
4. Engine Speed (rpm)
5. Number of Hours of Operation (hours)
6. Number of Start Attempts
7. Battery Voltage (DC volts)
8. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

H. The generator set mounted control shall include the following engine control functions:

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.

2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.

3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

6. The generator system shall be provided with a communications system that allows for monitoring of the system via a Modbus TCP connection to the facility's control system. Provide a Modbus memory map that allows for monitoring of the generator's operational state, alarm conditions, output voltage, current & power and fuel level.

I. Alternator Control Functions:

1. The generator set shall include an automatic digital voltage regulation system that is matched, and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

2. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

3. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit

shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

4. Controls shall be provided to monitor the KW load on the generator set and initiate an alarm condition (overload) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

5. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

6. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.

J. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

2.5 OUTDOOR WEATHER-PROTECTIVE HOUSING

A. The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and padlockable door latches shall be provided for all doors. Door hinges shall be stainless steel.

B. The CONTRACTOR shall be responsible for appropriate sizing, location, and proper functioning as per the manufacturer’s requirements.

C. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color. All surfaces of all metal parts shall be primed and painted.

D. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.

E. Generator Sound Attenuation: The outdoor weather-protection housing shall also provide sound attenuation by allowing a maximum of 85 dBA at a distance of 23 feet from the generator enclosure.

F. If the housing doors are elevated due to the fuel tank base, provide a portable platform system that is designed specifically for the generator assembly.

2.6 AUXILIARY POWER SYSTEM

A. The generator shall be provided a 480V auxiliary feeder from the facility power distribution system. The generator assembly shall be designed to accept that feeder and provide disconnecting means, step down transformer (120/208V) and distribution panelboards as required for a complete and operable system.

B. Provide lights and a light switch for the interior of the enclosure.

C. Provide fans and heaters as necessary to prevent cold starts and overheating.

D. Provide a 20A 120V convenience receptacle.

E. Provide power to the battery charging system.

PART 3 -- EXECUTION

3.1 SEQUENCE OF OPERATION

A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control.

B. The generator set shall complete a time delay start period as programmed into the control.

C. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:

1. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set and indicate “fail to crank” shutdown.

2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.

3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.

D. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.

E. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

F. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.

G. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

3.2 INSTALLATION

A. Equipment shall be installed by the CONTRACTOR in accordance with Final Submittals and Contract Documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with SUPPLIER's instructions and instructions included in the listing or labeling of UL listed products.

B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The CONTRACTOR shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment SUPPLIER.

C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with SUPPLIER’s instructions and seismic requirements of the site.

D. Equipment shall be initially started and operated by representatives of the SUPPLIER.

E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

F. Related electrical WORK involving connections, controls, switches, and disconnects shall be performed in accordance with the applicable sections of Division 16.

3.3 FACTORY TESTING

A. The generator set SUPPLIER shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided to the ENGINEER. Equipment supplied shall be fully tested at the factory for function and performance.

B. Factory testing may be witnessed by the OWNER and ENGINEER. Costs for travel expenses will be the responsibility of the OWNER and ENGINEER. SUPPLIER is responsible to provide two weeks’ notice for testing.

C. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

3.4 ON-SITE ACCEPTANCE

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the SUPPLIER, with required fuel supplied by Contractor. The ENGINEER shall be notified in advance and shall have the option to witness the tests.

B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two-hour full load test, and a one step rated load pickup test in accordance with NFPA 110.

Provide a resistive load bank and make temporary connections for full load test, if necessary.

3.5 TRAINING

A. The equipment SUPPLIER shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

3.6 SERVICE AND SUPPORT

A. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The SUPPLIER shall maintain an inventory of critical replacement parts at the local service organization, and in-service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

B. The SUPPLIER shall maintain model and serial number records of each generator set provided for at least 20 years.

3.7 WARRANTY

A. The generator set and associated equipment shall be warranted for a period of not less than 2 years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 263213

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SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes automatic transfer switches rated 600 V and less.

B. See Section 213113 "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps.

C. See Section 213213 "Electric-Drive, Vertical-Turbine Fire Pumps" for automatic transfer switches for fire pumps.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based.

B. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 70.

D. Comply with NFPA 99.

E. Comply with NFPA 110.

F. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Caterpillar; Engine Div.
b. Emerson; ASCO Power Technologies, LP.
c. GE Zenith Controls.
d. Kohler Power Systems; Generator Division.
e. Onan/Cummins Power Generation; Industrial Business Group.
f. MTU Energy.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

J. Battery Charger: For generator starting batteries.

1. Float type rated 10 A.
2. Ammeter to display charging current.
3. Fused ac inputs and dc outputs.

K. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

D. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase.

F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated.

G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer.

H. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548 "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Section 260529 "Hangers and Supports for Electrical Systems."

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

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SECTION 264313 - TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - Class C Main Entrance Panel Surge Suppression Device

1.1 DESCRIPTION

A. This Section describes the electrical and mechanical requirements for a high energy surge protective device. The specified surge protective device shall provide effective high energy surge diversion for application in ANSI/IEEE C62.41-1991 Location Category C3 environments. Testing per ANSI/IEEE C62.45-1992 using ANSI/IEEE C62.41 Category C3 waveforms and amplitudes. UL 1449 third edition listed. The specified surge protective device shall provide:

1. 200,000 transient amps, per phase, of surge protection.
2. Protection modes: L-N, L-G, L-L, N-G.
3. Green, power present LED on front panel.
4. Remote alarms relay contact.

1.2 STANDARDS

A. The specified device shall be designed, manufactured, tested and installed in compliance with:

1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
2. Federal Information Processing Standards Publication 94 (FIP PUB 94)
3. National Electrical Manufacturer Association (NEMA LS-1)
4. National Fire Protection Association (NFPA 20, 70, 75 and 78)
5. Underwriters Laboratories (UL 1449 third edition) listed.
6. CAN/C22.2 No. 8-M1986; CSA Electrical Certification Notice No. 516

B. The system individual units shall be UL listed under UL 1449 Third Edition Standard for Surge Protective Devices (SPD's) and the surge ratings shall be permanently affixed to the SPD.

1.3 ENTRANCE PANEL EQUIPMENT ELECTRICAL REQUIREMENTS

A. Environmental Requirements:

1. Operating Temperature: Operating temperature range shall be -40 to +140 degrees F
2. Storage Temperature: Storage temperature range shall be -40 to +185 degrees F
3. Relative Humidity: Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
4. Operating Altitude: The system shall be capable of operation up to an altitude of 11,000 feet above sea level.
5. Operating Voltage: Maximum continuous operating voltage shall be 115% of the nominal rated line voltage.
6. Power Frequency: The operating frequency shall be 50/60 Hz.

B. Electrical Requirements:

1. Unit Operating Voltage: The nominal unit operating voltage shall be as indicated Table I below:

Table I

Voltage Description	Surge Current Per Phase	Vpeak L-N	Vpeak L-G	Vpeak L-L	Vpeak N-G	I_n	MCOV
120T 120/240 VAC 1ph, 3W + gnd	200kA	700V	700V	1200V	700V	20kA	150V
120Y 120/208 VAC 3ph, 4W + gnd, wye	200kA	700V	700V	1200V	700V	20kA	150V
220Y 220/380 VAC 3ph, 4W + gnd, wye	200kA	1200V	1200V	2000V	1200V	20kA	320V
240D 240 VAC 3ph, 3W + gnd, delta	200kA	N/A	1000V	1000V	N/A	20kA	320V
240DCT* 240/120/120 3ph, 4W + gnd, hi-leg	200kA	700V 1200V**	700V 1000V**	1200V 1500V**	700V	20kA	150V
240Y 240/415 VAC 3ph, 4W + gnd, wye	200kA	1200V	1200V	2000V	1200V	20kA	320V
277Y 277/480 VAC 3ph, 4W + gnd, wye	200kA	1200V	1200V	2000V	1200V	20kA	320V
480D 480 VAC 3ph, 3W + gnd, delta	200kA	N/A	2500V	2500V	N/A	20kA	640V

*High-leg delta center tapped **Hi-leg

2. Unit shall be installed in parallel with the protected equipment.
3. Contractor is responsible for determining the correct voltage configuration and selecting the SPD for that configuration.
4. Protection per mode shall be: L-N 100kA, L-G 100kA, L-L 200kA, N-G 100kA.
5. The maximum surge current capacity per phase of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least: 1 Event at 150 kA. The surge life (8/20) shall be at least 10,000 occurrences at 6 kA. The surge protective capability shall be bi-directional and suppress both positive and negative impulses.
6. The device shall be designed so as to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the installation notes for best performance.
7. Equipment shall be as manufactured by MCG Electronics, Ditek, Square D, Eaton or approved equal with supporting test data.

1.4 ENTRANCE PANEL PROTECTION SYSTEM COMPONENTS

A. Diagnostics: Green solid-state LED indicators, per phase, shall be provided on the front cover to indicate protection status. Illuminated green LED's indicate full protection is present at the protector, and an extinguished LED shall indicate a reduction in protection on that phase.

B. NEMA 1, 12, 3R, 4, or 4X Enclosure as indicated on the Contract Drawings: Minimum 18-gauge steel. If no NEMA rating indicated on the Contract Drawings, the NEMA rating shall match or be better than the NEMA rating of the equipment the is protected by the SPD.

1.5 INSTALLATION AND MAINTENANCE

A. The unit shall be installed in accordance with the manufacturer's printed instruction to maintain warranty. All local and national codes must be observed.

B. Units shall be installed as close as possible to the panel board to which it is connected. Lead length shall be less than 18 inches.

C. Detailed maintenance instructions shall be printed on the front panel to ensure safety of maintenance personnel.

1.6 WARRANTY

A. Manufacturer to provide 10-year warranty to cover repair or replacement with a new device from date of substantial completion.

PART 2 - Class B Branch Panel Surge Protective Device

2.1 DESCRIPTION

A. These specifications describe the electrical and mechanical requirements for a high energy surge protective device. The specified surge protective device shall provide effective high energy surge diversion for application in ANSI/IEEE C62.41-1991 Location Category B3 environments. Testing per ANSI/IEEE C62.45-1992 using ANSI/IEEE C62.41 Category B3 waveforms and amplitudes. UL 1449 third edition listed. The specified surge protective device shall provide:

1. 150,000 transient amps, per phase, of surge protection.
2. Protection modes: L-N, L-G, L-L, N-G.
3. Green, power present LED, one per phase, on front panel.
4. Remote alarm relay contacts, Form C.

2.2 STANDARDS

A. The specified device shall be designed, manufactured, tested and installed in compliance with:

1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
2. Federal Information Processing Standards Publication 94 (FIP PUB 94)
3. National Electrical Manufacturer Association (NEMA LS-1)
4. National Fire Protection Association (NFPA 20, 70, 75 and 78)
5. Underwriters Laboratories (UL 1449 third edition) listed.
6. CAN/C22.2 No. 8-M1986; CSA Electrical Certification Notice No. 516

B. The system individual units shall be UL listed under UL 1449 Third Edition Standard for Surge Protective Devices (SPD's) and the surge ratings shall be permanently affixed to the SPD.

2.3 BRANCH PANEL EQUIPMENT ELECTRICAL REQUIREMENTS

A. Environmental Requirements:

1. Operating Temperature: Operating temperature range shall be -40 to +140 degrees F.
2. Storage Temperature: Storage temperature range shall be -40 to +185 degrees F.
3. Relative Humidity: Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
4. Operating Altitude: The system shall be capable of operation up to an altitude of 11,000 feet above sea level.
5. Operating Voltage: Maximum continuous operating voltage shall be 115% of the nominal rated line voltage.
6. Power Frequency: The operating frequency shall be 50/60 Hz.

B. Electrical Requirements:

1. Unit Operating Voltage: The nominal unit operating voltage shall be as indicated Table II below:

Table II

Voltage Description	Surge Current Per Phase	Vpeak L-N	Vpeak L-G	Vpeak L-L	Vpeak N-G	I_n	MCOV
120T 120/240 VAC 1ph, 3W + gnd	150kA	700V	700V	1200V	700V	20kA	150V
120Y 120/208 VAC 3ph, 4W + gnd, wye	150kA	700V	700V	1200V	700V	20kA	150V
220Y 220/380 VAC 3ph, 4W + gnd, wye	150kA	1200V	1200V	2000V	1200V	20kA	320V
240D 240 VAC 3ph, 3W + gnd, delta	150kA	N/A	1000V	1000V	N/A	20kA	320V
240DCT* 240/120/120 3ph, 4W + gnd, hi-leg	150kA	700V 1200V**	700V 1000V**	1200V 1500V**	700V	20kA	150V
240Y 240/415 VAC 3ph, 4W + gnd, wye	150kA	1200V	1200V	2000V	1200V	20kA	320V
277Y 277/480 VAC 3ph, 4W + gnd, wye	150kA	1200V	1200V	2000V	1200V	20kA	320V
480D 480 VAC 3ph, 3W + gnd, delta	150kA	N/A	2500V	2500V	N/A	20kA	640V

*High-leg delta center tapped **High-Leg

2. Unit shall be installed in parallel with the protected equipment. No series connected protective elements shall be used.
3. Contractor is responsible for determining the correct voltage configuration and selecting the SPD for that configuration.

4. Protection per mode shall be: L-N 75kA, L-G 75kA, L-L 150 kA, N-G 75 kA.
5. The maximum surge current capacity per phase of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least: 1 Event at 100 kA. The surge life (8/20) shall be at least 10,000 occurrences at 4 kA. The surge protection capability shall be bi-directional and suppress both positive and negative impulses.
6. The device shall be designed so as to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the installation notes for best performance.
7. Equipment shall be as manufactured by MCG Electronics, Ditek, Square D, Eaton or approved equal with supporting test data.

2.4 BRANCH PANEL PROTECTION SYSTEM COMPONENTS

A. Diagnostics: One green solid-state LED indicator, per phase, shall be provided on the front cover to indicate protection status. Illuminated green LED's indicate full protection is present at the protector, and an extinguished LED shall indicate a reduction in protection on that phase.

B. NEMA 1, 12, 3R, 4, or 4X Enclosure as indicated on drawings: Minimum 18gauge steel. If no NEMA rating indicated on the Contract Drawings, the NEMA rating shall match or be better than the NEMA rating of the equipment the is protected by the SPD.

2.5 INSTALLATION AND MAINTENANCE

A. The unit shall be installed in accordance with the manufacturer's printed instruction to maintain warranty. All local and national codes must be observed.

B. Units shall be installed as close as possible to the panel board to which it is connected. Lead length shall be less than 18 inches.

C. Detailed maintenance instructions shall be printed on the front panel to ensure safety of maintenance personnel.

2.6 WARRANTY

A. Manufacturer to provide 10-year warranty to cover repair or replacement with a new device from date of substantial completion.

PART 3 - Class A Local Panel / Control Panel Surge Device

3.1 DESCRIPTION

A. These specifications describe the electrical and mechanical requirements for a shunt installed AC power line surge device. The specified surge protective device shall provide effective energy surge diversion for application in ANSI/IEEE C62.41-1991 Location Category B3 environments. Testing per ANSI/IEEE C62.45-1992 using ANSI/IEEE C62.41 Category B3 waveforms and amplitudes. UL 1449 third edition listed. The specified surge protective device shall provide:

1. 50,000 transient amps, per phase, of surge protection.

2. Protection modes: L-N, L-G, L-L, N-G
3. Green, power present LED, red, protection reduced LED on front panel.

3.2 STANDARDS

A. The specified device shall be designed, manufactured, tested and installed in compliance with:

4. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
5. Federal Information Processing Standards Publication 94 (FIP PUB 94)
6. National Electrical Manufacturer Association (NEMA LS-1)
7. National Fire Protection Association (NFPA 20, 70, 75 and 78)
8. Underwriters Laboratories (UL 1449 third edition) listed.
9. CAN/C22.2 No. 8-M1986; CSA Electrical Certification Notice No. 516

The system individual units shall be UL listed under UL 1449 third Edition Standard for Surge Protective Devices (SPD's) and the surge ratings shall be permanently affixed to the SPD.

3.3 LOCAL PANEL EQUIPMENT ELECTRICAL REQUIREMENTS

A. Environmental Requirements:

1. Operating Temperature: Operating temperature range shall be -40 to +140 degrees F.
2. Storage Temperature: Storage temperature range shall be -40 to +185 degrees F.
3. Relative Humidity: Operation shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
4. Operating Altitude: The system shall be capable of operation up to an altitude of 10,000 feet above sea level.
5. Operating Voltage: Maximum continuous operating voltage shall be 115% of the nominal rated line voltage.
6. Power Frequency: The operating frequency shall be 50/60 Hz.

B. Electrical Requirements:

1. Unit Operating Voltage: The nominal unit operating voltage shall be as indicated in Table III below:

Table III

Voltage Description	Surge Current Per Phase	Vpeak L-N	Vpeak L-G	Vpeak L-L	Vpeak N-G	I_n	MCOV
120T 120/240 VAC 1ph, 3W + gnd	50kA	700V	700V	1200V	700V	20kA	150V
120Y 120/208 VAC 3ph, 4W + gnd, wye	50kA	700V	700V	1200V	700V	20kA	150V
220Y 220/380 VAC 3ph, 4W + gnd, wye	50kA	1200V	1200V	2000V	1200 V	20kA	320V
240D 240 VAC 3ph, 3W + gnd, delta	50kA	N/A	1000V	1000V	N/A	20kA	320V

240DCT* 240/120/120 3ph, 4W + gnd, hi-leg	50kA	700V 1200V**	700V 1000V**	1200V 1500V**	700V	20kA	150V
240Y 240/415 VAC 3ph, 4W + gnd, wye	50kA	1200V	1200V	2000V	1200 V	20kA	320V
277Y 277/480 VAC 3ph, 4W + gnd, wye	50kA	1200V	1200V	2000V	1200 V	20kA	320V
480D 480 VAC 3ph, 3W + gnd, delta	50kA	N/A	2500V	2500V	N/A	20kA	640V

*High-leg delta center tapped **High-Leg

2. Unit shall be installed in parallel with the protected equipment.
3. Contractor is responsible for determining the correct voltage configuration and selecting the SPD for that configuration.
4. Protection per mode shall be: L-N 25 kA, L-G 25 kA, L-L 50 kA, N-G 25 kA.
5. The maximum surge current capacity per phase of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least: 1 Event at 50 kA, the surge life shall be at least 200 events at 6kA and 20,000 events at 2kA. The surge protection capability shall be bi-directional and suppress both positive and negative impulses.
6. The device shall be designed so as to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the installation notes for best performance.
7. Equipment shall be as manufactured by MCG Electronics, Ditek, Square D, Eaton or approved equal with supporting test data.

3.4 LOCAL PANEL PROTECTION SYSTEM COMPONENTS

A. MOVS: The device shall be constructed of multiple 32 mm metal oxide varistors.

B. Self-Diagnostics: Solid state red and green LED indicators shall be provided on the front cover to indicate AC power present at the device and protection status

C. NEMA 1, 12, 3R, 4, or 4X enclosure as indicated on the drawings: Minimum 18-gauge steel provided with mounting flanges. If no NEMA rating indicated on the Contract Drawings, the NEMA rating shall match or be better than the NEMA rating of the equipment the is protected by the SPD.

3.5 INSTALLATION AND MAINTENANCE

A. The unit shall be installed in accordance with the manufacturer's printed instruction to maintain warranty. All local and national codes must be observed.

B. Units shall be installed as close as possible to the panelboard to which it is connected. Lead length shall be less than 18 inches.

C. Detailed maintenance instructions shall be printed on the front panel to ensure safety of maintenance personnel.

3.6 WARRANTY

A. Manufacturer to provide 10-year warranty to cover repair or the providing of a new device from date of substantial completion.

PART 4 - Class A Surge Suppression Device installed within Protected Equipment

4.1 DESCRIPTION

A. These specifications describe the electrical and mechanical requirements for a series installed AC power line surge protective device. The specified surge protective device shall provide effective energy surge diversion for application in ANSI/IEEE C62.41-1991 Location Category A3 environments. Testing per ANSI/IEEE C62.45-1992 using ANSI/IEEE C62.41 Category A3 waveforms and amplitudes. UL 1449 recognized. The specified surge protective device shall provide:

1. 10,000 transient amps of surge protection.
2. L-N, L-G, H-G protected modes.
3. Green protection present LED.
4. EMI-RFI Filter.
5. Low profile construction.

4.2 STANDARDS

A. The specified device shall be designed, manufactured, tested and installed in compliance with:

1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, and C62.45)
2. Federal Information Processing Standards Publication 94 (FIP PUB 94)
3. National Fire Protection Association (NFPA 20, 70, 75 and 78)
4. Underwriters Laboratories (UL Second Edition 1449 Recognized)
5. National Electrical Manufacturer Association (NEMA LS-1)
6. CAN/C22.2 No. 8-M1986; CSA Electrical Certification Notice No. 516

B. The system individual units shall be UL recognized under UL 1449 third Edition Standard for Surge Protective Device (SPD).

1.3 LOCAL EQUIPMENT ELECTRICAL REQUIREMENTS

A. Environmental Requirements:

1. Operating Temperature: Operating temperature range shall be –40 to +140 degrees F.
2. Storage Temperature: Storage temperature range shall be –40 to +185 degrees F.
3. Relative Humidity: Operating shall be reliable in an environment with 0% to 95% non-condensing relative humidity.
4. Operating Altitude: The system shall be capable of operation up to an altitude of 13,000 feet above sea level.
5. Operating Voltage: Maximum continuous operating voltage shall be 115% of the nominal rated line voltage.

6. Power Frequency: The power frequency range shall be 50-400 Hertz.

1.4 Electrical Requirements:

A. Unit Operating Voltage: The nominal unit operating voltage shall be as indicated in Table IV below.

Table IV

Voltage / Description	Joules 8/20us	Clamp @ 1mA	V Peak L - N
120 VAC 1phase, 2W + G	500	220V	392V
240 VAC 1phase, 2W + G	900	425V	760V

B. Unit shall be installed in series or in parallel with the protected equipment.

C. The maximum surge current capacity per phase of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least: 1 Event at 10 kA. The surge life (8/20us) shall be at least 10,000 occurrences at 500A. The surge protection capability shall be by-directional and suppress both positive and negative impulses.

D. The device shall be designed so as to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the installation notes for best performance.

E. Equipment shall be as manufactured by MCG Electronics, Ditek, Transector or approved equal with supporting test data.

F. The device shall contain a common mode noise filter with specifications as in Table V below:

Table V

Filter Attenuation (50 ohm)	Frequency
-20db	45 kHz
-30db	75 kHz
-40db	150 kHz
-50db	250 kHz
-60db	450 kHz

4.5 EQUIPMENT LEVEL PROTECTION SYSTEM COMPONENTS

A. MOVS: The device shall be constructed of multiple metal oxide varistors.

B. Self-Diagnostics: An illuminated green solid-state LED indicator shall be provided on the front cover to indicate protection is present at the device.

C. Connection: Solderless Screw Terminals or hard-wired leads less than 12 inches.

D. Enclosure: High-impact plastic.

4.6 INSTALLATION AND MAINTENANCE

A. The unit shall be installed in accordance with the manufacturer's printed instruction to maintain warranty. All local and national codes must be observed.

B. Units shall be installed within the equipment to which it is connected.

4.7 WARRANTY

A. Manufacturer to provide 10-year warranty to cover repair or replacement with a new device.

END OF SECTION 264313

SECTION 265000 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.

1.2 SCOPE OF WORK

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting fixtures.

1.3 QUALITY ASSURANCE

A. Reference Standards:

1. National Electrical Code (NEC)
2. UL Standard #57, Electric Lighting Fixtures
3. UL Standard #844, Electric Lighting Fixtures for Use in Hazardous Location
4. UL Standard #1570, Fluorescent Lighting Fixtures
5. UL Standard #1571, Incandescent Lighting Fixtures
6. UL Standard #1572, High Intensity Discharge Lighting Fixtures
7. Illuminating Engineering Society (IES)
8. All applicable local lighting ordinances

B. Miscellaneous:

1. Lamps are identified for each luminaire in the Lighting Fixture Schedule on the Plans.
2. Lighting fixtures and electrical components:
    a. UL labeled, complete with lamps.
    b. Rated for area classification as indicated.
        1) All lighting in classified areas are to be of the T3 temperature class unless otherwise indicated, refer to Table 500.8(B) of the NEC.
    c. Lighting shall meet OSHA requirements.
3. On the Plans, the location of lighting fixtures is intended to be used as a guide.
    a. Field conditions may affect actual locations.
    b. Coordinate with other trades to avoid conflicts in mounting of fixtures and other equipment.
4. The quality standard is established by the fixture listed in the Lighting Fixture Schedule.
    a. This quality standard includes, but is not necessarily limited to construction features, materials of construction, finish, and photometrics.

1.4 SUBMITTALS

A. The following shall be submitted to the Engineer for review:

1. Acknowledgment that products submitted meet requirements of standards referenced.
2. Manufacturer’s technical information on products to be used including photometric performance curves for the fixture and ballast data.
3. Acknowledgment that products submitted are UL listed.
4. When general data sheets constitute part of the submittal, identify the products to be used on this project.
5. Manufacturer’s installation instructions.
6. Identification of fixtures by Lighting Fixture Schedule.
7. UL nameplate data (Voltage, wattage, etc.).
8. Finishes, colors, and mounting type.
9. Pole, fixture, and accessories.
10. Pole wind loading.

B. Contractor shall submit shop drawings, manufacturer's data sheets, and a complete wiring diagram detailing all connections to the electrical system in accordance with Section 013300 “Contractor Submittals” and Section 260000 “General Electrical Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Lamps shall be manufactured by:

1. General Electric
2. North American/Phillips
3. Sylvania
4. Approved equal.

B. Lighting fixtures shall be provided as indicated on the Lighting Fixture Schedule on the Plans.

C. Lighting ballasts shall be manufactured by:

1. General Electric
2. Advance
3. Jefferson
4. Universal
5. Bodine
6. Lithonia
7. Approved equal

D. Light poles shall be as indicated on the Plans. Include base template, anchor bolts, cadmium-plated hardware and pole grounding lug, hand-hole, anchor base and bolt covers. Pole foundations shall be as indicated on the Plans.

2.2 MATERIALS

A. General:

1. Lamps:
   a. See lighting fixture schedule on Plans for wattage, voltage and number required.
2. All Fixtures:
   a. There shall be no live parts normally exposed to contact.
   b. When intended for use in wet area:
      1) Mark fixtures “suitable for wet locations.”
   c. When intended for use in damp areas:
      1) Mark fixtures “suitable for damp locations” or “suitable for wet locations.”
   d. In wet or damp area, install fixtures so that water cannot enter or accumulate in the wiring compartment, lamp-holder, or other electrical parts.
   e. Gasket seals: Urethane foam
   f. Diffusers: UV stabilized acrylic plastic
3. Underground wiring:
   a. Provide all wiring runs with separate green grounding conductor.
   b. Ground all pole bases.
4. Pole wiring from base to ballast:
   a. No. 12 type XHHW.
   b. Each phase shall be protected by a 30A, 600V, type Tron waterproof fuse-holder, Bussman “Limitron” type fuse, size rating 3-times load current.

B. Incandescent Lamps:

1. No incandescent lamps shall be allowed.

C. Fluorescent Lamps:

1. Rapid start
2. Cool white (F32T8/41K-85CRI and F96T12/41K-70CRI/HO/ES)
3. Energy efficient or standard as noted on the lighting fixture schedule.

D. High-Pressure Sodium Lamps:

1. No High-Pressure Sodium Lamps shall be allowed.

E. Metal Halide Lamps:

1. No Metal Halide Lamps shall be allowed.

F. LED:

1. Lifespan: 50,000 hour
2. Minimum CRI: 70 outdoors, 80 indoors
3. Color Temperature: 3500K outdoors, 4000K indoors

G. Furnish a minimum of 2 lamps, or ten percent spare lamps of each type and wattage, whichever is greater.

2.3 FIXTURES

A. Fluorescent Lighting Fixtures:

1. Ballast:
    a. Rapid start, high power factor type
    b. CBM/ETL certified
    c. Sound rating A
    d. Two internal automatic-resetting thermal switch devices for coil and capacitor
2. Internal wiring: AWM, TFN or THHN
3. Channel and end plates: 22 GA steel
4. Steel door frame and socket track: 20 GA steel
5. Channel cover: 24 GA steel
6. Emergency ballast:
    a. Integral rechargeable nickel-cadmium battery, battery charger, and automatic transfer circuitry.
    b. Charging indicator light.
    c. Test Switch.
    d. Provide a minimum of 900 lumen output for 90 minutes upon loss of normal power.
    e. Mounted integral to the fixture.
    f. UL 924 listed.
7. Provide fixtures with emergency ballasts with permanent caution labels warning that the fixture is fed from an un-switched source
    a. Provide emergency ballast also with a similar caution label.

B. LED Lighting Fixtures:

1. Heavy duty two piece, die cast aluminum housing.
2. Silicon gasketing for moisture protection
3. Polyester powder finish for impact, corrosion and UV resistance
4. Cast-in aluminum hinges for tool-less lens removal.
5. Thermal and shock resistant clear borosilicate glass refractor.
6. Field replaceable LED light engine and driver.

2.4 EMERGENCY FLUORESCENT POWER UNIT

1. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
    a. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.

5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.5 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.6 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

2.7 MISCELLANEOUS ELECTRIC DEVICES

A. PHOTOELECTRIC CONTROL UNITS shall meet the following requirements:

1. Cadmium sulfide photocell
2. Aluminum weatherproof enclosure
3. 30 amp rated contacts
4. 120-volt AC power
5. The Photoelectric control unit shall be Tork Model 2100, or equal.

B. MOTION SENSORS shall meet the following requirements:

1. 110° field of view, 60-foot range
2. Adjustable time setting from 15 seconds to 15 minutes
3. Operating temperature of -20 to + 130 °F.
4. Complete outdoor, weatherproof sensor with complete mounting hardware
5. UL listed
6. The motion sensor(s) shall be manufactured by Leviton Model 50500-H or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Comply with NFPA 70 for minimum fixture supports.

C. Install lamps in all luminaires.

D. Replace all failed fluorescent, incandescent, metal halide, mercury vapor, high pressure sodium and LED lamps with new lamps prior to final acceptance by Owner.

E. Surface and flush mounted fixtures shall be solidly connected to a junction box. Suspended fixtures shall be hung utilizing pendant mounting or stainless-steel chains and hooks. Each suspended fixture shall be electrically connected by a length of Type SO flexible cord. 3 conductor No. 14 AWG, minimum, with a twist-lock receptacle mounted in an individual junction box. Plugs and receptacles shall be as manufactured by Hubbell, General Electric Company, or equal.

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

G. Install with approved mounting hardware following manufacturer’s recommendations.

H. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports, and nonmetallic channel and angle supports.

1. Do not support fixture from conduit system.
2. Do not support fixture from outlet boxes.

I. Pole mounted fixtures shall be mounted on steel or aluminum poles as indicated on the Plans. All metal poles shall be bonded to the facility ground system. Poles shall have adequate handholes and weatherproof receptacles where indicated.

J. All anchor bolts and nuts shall be stainless steel. Contractor shall paint all steel poles with aluminum paint or other color in accordance with these Contract Documents.

K. Fixture mounting heights and locations indicated on the Plans are approximate and are subject to revision in the field where necessary to avoid conflicts and obstructions.

3.2 ADJUSTING AND CLEANING

A. Wipe all lighting fixture reflectors, lenses, lamps, and trims clean after installation and prior to acceptance of Project by Owner.

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION 265000

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SECTION 283100 – FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fire alarm system shall consist of fire alarm control panel or networked nodes, of the same make and CSFM (California State Fire Marshall) listed for the application.

2. Labor, equipment, materials, connections, testing, and performance of operations in the installation of fire alarm system.

B. Related Requirements:

1. Division 01 General Requirements.

2. Section 211313: Fire Sprinkler Systems.

3. Section 260000: General Electrical Requirements.

4. Section 260519: Low-Voltage Wire (600 Volt AC).

5. Section 260526: Grounding and Bonding.

6. Section 260533: Raceways, Boxes, Fittings, and Supports.

1.02 SYSTEM REQUIREMENTS

A. Fire detection system shall continually supervise and monitor the following initiating, signaling, and monitoring circuits:

1. Manual fire-pull stations.

2. Smoke and heat detectors, duct detectors, including those installed under other sections.

3. Fire sprinkler flow and tamper switches. In existing installations also include PIV tamper switches.

4. Alarm signaling circuits including alarm bells, horns and visual alarm units.

5. Annunciators.

6. Power supplies and batteries.

B. System controls shall be UL listed for power limited applications in accordance with California Electrical Code.

C. The fire alarm devices and equipment shall be listed for installation for the fire alarm control panel to which they are being connected.

D. Complete installation shall conform to the version of NFPA 72, California Fire Code, California Building Code (CBC), and California Electrical Code (CEC) as approved by Engineer on stamped drawings.

E. System labels and devices programming addresses shall be based on final signage and building labeling submittals. For existing facilities contractor shall obtain from Owner Authorized Representative a copy of the current site layout and building labeling designations.

1.03 CERTIFICATION

A. Certification: Installation of fire alarm system shall not begin until Shop Drawings, including State Fire Marshal listing numbers of fire alarm components, are submitted and reviewed by the Engineer. Written certification by fire alarm equipment distributor or manufacturer shall be submitted to the Engineer stating that system and its component parts are as approved and listed by the State Fire Marshal, and that the design conforms to requirements set forth in CBC.

1.04 PERFORMANCE

A. System shall be fully programmable, configurable, and expandable in the field without special tools or PROM programmers and shall not require replacement of memory ICs. Installer shall provide a CD of system installed software, site specific system programming and information and tools required to re-program or modify the system.

1.05 SYSTEM FUNCTIONAL OPERATION

A. When a fire alarm condition is detected by one of the system alarm initiating devices, the following functions shall occur:

1. System alarm LED shall flash.

2. Local sounding device in panel shall be activated.

3. The LCD display shall indicate type of device, custom label location label and point status alarm condition.

4. Appropriate change of status message shall be transmitted to remote annunciator(s).

5. Automatic programs assigned to alarm point shall be executed and associated indicating devices and relays activated.

6. In the event of a fire alarm control panel activation, manual and automatic electronic tone or electromechanical bell class passing signals shall be disabled.

B. Trouble and Supervisory Conditions.

1. When any trouble condition is detected the following functions shall occur:

a. System trouble LED shall flash.

b. Local sounding device in panel shall be activated.

c. The LCD display shall indicate the type of trouble and custom label location associated with the trouble condition and its location. Unacknowledged alarm messages shall have priority over trouble messages. If such an alarm is displayed, then trouble messages shall not be displayed.

d. Appropriate message shall be transmitted to remote annunciators.

C. When any supervisory condition occurs such as a sprinkler valve tamper, the following function shall occur:

1. System supervisory LED shall flash.

2. Local sounding device in panel shall be activated.

3. Appropriate message shall be transmitted to remote annunciators.

D. Activation of control panel ACKNOWLEDGE switch in response to a single new alarm, trouble or supervisory condition shall silence panel sounding device and change system alarm, trouble, or supervisory LED from flashing to steady-ON. If additional new alarm, trouble, or supervisory conditions exist in the system; activation of this switch shall advance display to next alarm, trouble, or supervisory condition that exists, and shall not silence local audible device or change LED to steady until new conditions have been so acknowledged. New alarm conditions shall always be displayed before new trouble conditions. Occurrence of a new alarm, trouble, or supervisory condition shall cause panel to resound, and sequences as described above, shall repeat.

E. Activation of the signal silence switch shall cause appropriate notification (indicating) appliances and relays to return to normal condition. Selection of notification appliance circuits and relays silenced by this switch shall be fully programmable.

F. Activation of system reset switch shall cause electronically latched initiating devices or zones, as well as associated output devices and circuits, to return to normal condition after sixty seconds of alarm. If alarm conditions exist in system after system reset switch activation, system shall then re-sound alarm conditions as indicated hereafter.

G. Activation of lamp test switch shall turn on LED indicators, LCD display, and local sounding device in panel, and then return to previous condition.

H. Fire alarm indicating appliances may be silenced or extinguished, after one minute, by operating signal silence switch at the FACP or by use of key supervised alarm silence switch at remote annunciators. A subsequent zone alarm shall reactivate signals. Audible indicating appliances shall be automatically silenced after no less than five nor more than ten minutes of operation. Visual indicating appliances shall be extinguished at system reset, or automatically after no less than five nor more than ten minutes of operation. Fire sprinkler flow alarm bells shall not silence until the contacts in the fire sprinkler flow

switch return to the normal non-alarm state. Appropriate signage must be installed on or next to the sprinkler alarm bell.

I. System's circuits including but not limited to initiation, indicating, and equipment interfacing shall be monitored for open or short circuit and ground fault conditions, these conditions shall be indicated on the Fire Alarm Control Panel and Annunciator displays while remaining circuits continue to operate normally.

J. Notification appliance circuits shall be silenceable for testing purposes by authorized persons. Protected pass-codes, keys, or another secure method that does not require entering into the system programming shall be used.

1.06 POWER REQUIREMENTS

A. The fire alarm control panel and remote power supply shall receive 120 VAC power, 60 Hz, through a dedicated 20 amps circuit. Circuit breaker protection for the dedicated fire alarm power circuits shall be equipped with a handle lock-on device; the breaker handle shall be colored red and labeled "FIRE ALARM". Clearly label the Electrical panel name, location and circuit number on the inside of the fire alarm control panel and remote power supplies using a p-touch style labeling system. Transient voltage surge suppression shall be provided at the 120VAC input terminal.

B. System shall be provided with sufficient battery capacity to operate entire system upon loss of normal 120 VAC power, in a normal quiescent mode, for a period of 24 hours with five minutes of alarm indication at end of this period. System shall automatically transfer to standby batteries upon power failure. Battery charging and recharging operations shall be automatic. Batteries, once discharged, shall recharge at a rate to provide a minimum of 70 percent capacity in 12 hours.

C. Circuits requiring system operating power shall be 24 VDC and shall be individually protected at control panel.

1.07 SUBMITTALS

A. Provide in accordance with Division 01.

B. Component Plan Submittal: Availability and listing for its application shall be verified for system components before presentation of the submittal. Include the following information and details as applicable:

1. Installer name, address, telephone number.

2. List of system components, equipment and devices, including manufacturer model numbers, quantity and California State Fire Marshal listing numbers and mounting heights.

3. Copies of manufacturer specification sheets for equipment and devices indicated. Highlight or identify the specific components on Catalog cut sheets.

4. Voltage Drop Calculations: Include the following information for the worst case:

a. Point-to-point or Ohms law calculations.

b. Zone used in calculations.

c. Voltage drop percent. Voltage drop shall not exceed manufacturer's requirements. If voltage drop exceeds ten percent, indicate manufacturer listed operating voltage ranges for equipment and devices.

5. Battery types, amp hours, and load calculations including the following:

a. Normal operation: 100 percent of applicable devices for 24 hours to equal control panel amps plus list of amps per device that draw power form the panel during standby power condition including, but not limited to, zone modules, detectors and devices as identified.

b. Alarm condition: 100 percent of applicable devices for five minutes to equal control panel amps plus list of amps per device that draw power from panel during alarm condition including, but not limited to, the following:

1) Zone modules.

2) Signal modules.

3) Detectors.

4) Signal devises.

5) Annunciator.

6) Other devices as identified.

c. Normal operation plus alarm operation load calculation shall include total amp hours required and total amp hours provided.

6. Provide one copy of testing procedures.

C. Shop Drawings: Provide Shop Drawings, in the same size as the design Drawings, include the following:

1. Provide drawing scale, elevations of system enclosures, and actual layout of the Fire Alarm Control Panel, power supply, annunciator, and main system components.

2. Site Plan indicating PIV and related fire sprinkler system devices and equipment to be monitored or supervised; such as water flow valves, and main equipment such as control panels, power supplies, annunciators, and components such as outdoor wall-mounted horns, sprinkler bells, pull boxes, underground pull boxes , wiring routes on buildings exterior and underground locations. In each conduit or raceway run indicate conduit sizes, and quantities and type of wires.

3. Complete battery calculations, and voltage drop calculation shall be included; these calculations shall be based on the devices maximum UL current rating.

4. One line drawing for the entire system network indicating system components and wiring. The one line diagram shall show but not be limited to panel to panel interconnections, conductors gage and quantity, conduit size and type (designation) and specific function.

5. System panel one-line drawings indicating the quantity and type (designation) of conductors entering and exiting the fire alarm terminal cabinet in each building (enclosure) for initiating, notification, or other command control functions required for complete system operation:

    a. Individual floor or building plan view drawings indicating device locations including end of line resistors “EOLR” in accordance with the legend provided.

    b. Individual point addresses for initiation and notification devices.

    c. Device “typical” wiring diagrams. These drawings shall indicate specific termination details for peripheral equipment and interface devices.

6. Provide interfacing with equipment furnished by others including voltages, and other required coordination items. Refer to 3.01-B.

7. Each of the pictorial diagrams included shall appear identical to the products they are intended to depict, in order to speed installation of the system, and to enhance the accuracy of the installation Work. Typical wiring diagrams or catalog sheets are not permitted.

8. Contractor is solely responsible for the accuracy and completeness of shop drawings. Shop Drawings shall be prepared in the latest version of AutoCAD with electronic copies submitted along with half sized Shop Drawings.

9. Other installation and coordination drawings specifically related to this section shall be included as follows:

    a. Size A (8 ½ by 11) and size B (11 by 17) shall be bound into the manual.

    b. Larger drawings shall be folded and inserted into transparent envelopes and bound into the manual.

10. Installation and coordination drawings for items in other sections shall be included with submittal of Shop Drawings. Submit blue line copies and one reproducible copy of installation and coordination drawings.

11. Samples: Provide Samples of material and equipment as required by the Engineer. If Samples are requested, they shall be submitted within ten days from date of request.

D. Submittal of Equivalent Systems:

1. In addition to the submittal requirements of this section, if an equivalent system listed in Section 2.01A is submitted in lieu of the designed, the Contractor shall also submit a letter stating that the system is equivalent, and that device locations and quantities of devices are unchanged. Attached to this letter shall be a copy of the revised equipment schedule with corresponding CSFM numbers and a cut sheet for each item.

E. Modifications or additions to existing fire alarm systems shall be compatible and of the same manufacturer as the existing system. Contractor shall be solely responsible for

engineering, plan check and any fees resulting form an installation that deviates from this requirement.

F. Prior to Substantial Completion submit to the Engineer of Record and to Owner Authorized Representative a complete updated set of the Shop Drawings showing changes made to the Fire Alarm System during construction. These drawings will become the System As-Built Drawing set for the Fire Alarm System Owner's Manual.

1.08 QUALITY ASSURANCE

A. Installer shall have successfully completed at least five projects of equal scope in the past five years, and have been in business of furnishing and installing fire alarm systems of this type for at least five years.

B. Installer shall be a factory authorized distributor and service provider for the brand of equipment offered and shall provide documentation to the Engineer upon request.

C. Installer shall maintain a fully equipped service organization capable of furnishing repair service to the equipment and shall maintain a spare set of major parts for the system at all times.

D. Installer shall furnish a letter from manufacturer of equipment certifying equipment has been installed according to factory standards and that system is operating properly.

E. Certifications: Installer shall submit certification from the equipment manufacturer indicating that installer is an authorized representative of the equipment manufacturer and is trained on network applications.

F. Materials and equipment installed shall be new.

G. Equipment in this specification shall be furnished and installed by the Authorized Factory Distributor of the equipment. Furnish a letter from the manufacturer of major equipment, which certifies that the installer is an authorized distributor and that the equipment has been installed according to factory intended practices. Furnish a written guarantee from the manufacturer that they will have a service representative assigned to this area for the life of the equipment.

H. Installer shall be Underwriters Laboratory (UL) listed company under the UUJS classification, and shall certify that the installation has been made in accordance with UL requirements.

I. The fire alarm contractor shall have a NICET II Certified Technician on staff in their facility directly involved with this project to ensure technical expertise to this project and adherence with these specifications.

J. Contractor or Installer's Electricians and fire and life safety technicians shall be certified in accordance with Labor Code sections 3099, and 3099.2, and section 209.0 of the California Code of Regulations.

K. System startup and testing shall be performed under the direct observation of the Project Inspector and Owner's Approved Representative (OAR). Provide a legible half size reproduction of the original completed fire alarm red-line drawings (this copy will be retained by the Owner), an accurate copy of the fire alarm system points list, and a copy of the construction drawings on CD in AutoCad format.

L. At the time of installation the most current software package available shall be provided.

M. Provide at the time of Owner Acceptance of the installation, equipment, and updated software which is to include the appropriate operating system, pass-codes, electronic keys and program disks, manuals and cables employed in the installation of the system. These components shall be delivered to the OAR.

N. Provide a backup copy of the most current software revision, in disk format. This copy shall be delivered to the OAR

O. A software license agreement shall be made available for the responsible Owner representative to sign at the time of training.

1.09 WARRANTY

A. The Fire Alarm Equipment Manufacturer shall provide a three year material warranty. Installer shall provide a three year labor warranty.

B. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer for a period of five years after expiration of the warranty.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Fire alarm equipment shall be standard products of the Notifier Co., Edwards Systems Technology, Siemens Building Technologies, Inc. Simplex Grinnell, Johnson Controls and Gamewell-FCI, or equal.

B. Catalog and model numbers listed are intended to establish type and quality of equipment and system design as well as operating features required. Deviations from intended functions of specified system are not permitted. Equipment shall not be ordered or installed until such equipment has been reviewed and approved by the Engineer.

C. Products specified below are based on Notifier system components. For other manufacturers approved system components, refer to Attachment A.

2.02 FIRE ALARM CONTROL PANEL (FACP)

A. Furnish Notifier Model No. NFS-320, (CSFM 7165-0028:0243), or NFS2-640 (CSFM 7165-0028:0243), or NFS2-3030 (CSFM 7165-0028:0224) Fire Alarm Control Panels as indicated on drawings.

B. Operator Control:

1. Acknowledge Switch: Activation of control panel acknowledge switch in response to a single new trouble or alarm condition shall silence panel sounding device and change system alarm or trouble LED from flashing to steady-ON. If additional new alarm or trouble conditions exist in system, activation of this switch shall advance display to next alarm or trouble condition that exists, and shall not silence local

audible device or change LED to steady until new conditions have been so acknowledged. New alarm conditions shall always be displayed before new trouble conditions. Occurrence of a new alarm or trouble condition shall cause panel to resound, and sequences as described above, shall repeat.

2. Signal (Alarm) Silence Switch: Activation of the signal silence switch shall cause programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully fielded programmable within the confines of applicable standards at the job site. The FACP software shall include silence inhibit and auto-silence timers.

3. Alarm Activate (Drill) Switch: Alarm activate switch shall activate notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

4. System Reset Switch: Activation of the System Reset switch shall cause electronically-latched initiating devices, appliances or software zone, as well as associated output devices and circuits, to return to their normal condition.

5. Lamp Test Switch: Switch shall activate local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personnel.

6. Hot Button Switch: Hot Button Key switch shall be provided in FACP to disable all output devices for testing or repair of system. Key switch shall silence all horn and strobes, disable PA cutouts, HVAC shutdowns, door closures, and Autonomous PA systems. Key switch shall be password protected to enable function. LED indicator shall illuminate a trouble condition while Hot Button Switch is activated and shall turn off when system is re-enabled.

C. System Capacity and General Operation

1. The control panel shall provide, or be capable of expansion to 318 intelligent or addressable devices for the NFS-320 or 636 Intelligent or addressable devices for the NFS2-640 and 3180 intelligent, addressable devices for the NFS2-3030.

2. The control panel or each network node shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of two amps at 30 VDC. It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notifications Appliance Circuits.

3. The control panel or each network node shall support up to two output modules (signal or relay) for a total of ten circuits for the NFS-320 or eight output modules (signal or relay), each with eight circuits for a total of 64 circuits for the NFS2-640. The NFS2-3030 shall support 12 output modules for a total of 96 circuits. Programmable notification appliance circuits shall be class B.

4. The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad with easy touch rubber keys for the field programming and control of the fire alarm system.

5. The system shall be programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.

6. The system shall allow the programming of any input to activate any output or group of outputs. The FACP shall support up to 20 logic equations, including "and" "or" and "not", or timed delay equations to be used for advanced programming. Logic equations shall require the use of a PC with software utility designed for programming.

7. The FACP or each network node shall provide the following features:

    a. Drift compensation to extend detector accuracy over life. Drift Compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.

    b. Detector Sensitivity tests, meeting requirements of NFPA 72 Chapter seven.

    c. Maintenance alert, with two levels (maintenance alert or maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.

    d. Nine sensitivity levels for alarm, selected by detector. The alarm level range shall be 0.5 to 2.35 percent per foot for photoelectric detectors and 0.5 to 2.5 percent per foot for ionization detectors. The system shall also support sensitive advance detection laser detectors with an alarm level range of 0.03 percent per foot to one percent per foot. The system shall also include up to nine levels of Pre- alarm, selected by detector, to indicate impending alarms to maintenance personnel.

    e. Circuit boards, programming, and interconnecting cables to enable the system to display or print system reports.

    f. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.

    g. PAS pre-signal, meeting NFPA 72 requirements.

    h. Rapid manual station reporting (less than three seconds) shall meet NFPA 72 Chapter one requirements for activation of notification circuits within ten Seconds of initiating device activation.

    i. Periodic detector test, conducted automatically by the software.

    j. Self optimizing pre-alarm for advance fire warning, which allows each detector to learn its particular environment and set its pre-alarm level to just above normal peaks.

    k. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.

    l. Walk test, with a check for two detectors set to same address.

    m. Control-by-time for non-fire operations, with holiday schedules.

n. Day or night automatic adjustment of detector sensitivity.

o. RS 232 serial port to support a District supplied printer to be used for silent testing and certification of the system.

8. The FACP shall be capable of coding main panel(s) node notification circuits in temporal code (NFPA 72 A-2-2.2.2).The panel shall also provide a coding option that will synchronize specific strobe lights designed to accept a specific "sync pulse".

D. System Display:

1. The 80-character display shall provide the controls and indicators used by the system operator: The 80 character display shall include the following operator control switches; Acknowledge, Alarm, Silence, Alarm Activate (drill), System Reset and Lamp Test.

2. The display shall annunciate status information and custom alphanumeric labels for intelligent detector, addressable modules, internal panel circuits, and software zones.

3. The 80-character display shall provide ten Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC Power and Network Communication, Fire Alarm, Pre alarm Warning, Security Alarm, Supervisory Event, System Trouble, Alarm Silence, Disabled Points, CPU failure.

4. The 80-character display shall use ten "soft" keys for screen navigation or to accomplish dedicated programming functions. Full programming access shall require use of a laptop and the proper programming utility. The programming utility shall be provided to the OAR who will forward it to the local maintenance area representative.

5. The system shall support the display of battery charging current and voltage on the LCD display.

E. Signaling Line Circuits (SLC):

1. Each FACP shall support a minimum of one SLC for the NFS-320 for the Notifier NFS2-640 or ten SLC's for the NFS2-3030. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a loop capacity of 318 devices.

2. CPU shall receive analog information from intelligent detectors to be processed to determine whether normal, alarm, pre-alarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors including the accumulation of dust in each detector. The analog information shall also be used for automatic detectors testing and for the automatic determination of detector maintenance requirements.

F. Enclosures:

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

2. The back box and door shall be constructed of 0.030 steel with provisions for electrical conduit connections into the sides and top.

3. The supplied door shall include a key lock and shall include glass or other transparent opening for viewing of indicators. For convenience, the door may be site configured for either right or left hand hinging.

G. Power Supply:

1. An off-line switching power supply shall be available for the fire alarm control panel or network node and provide six amps of available power for the NFS2-640, and 4.5 amps for NFS2-3030 and six amps for the NFS-320 for control panel and peripheral devices.

2. Provisions shall be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.

3. Over-current protection shall be provided on power outputs. The power supply shall provide an integral battery charger. Battery arrangement may be configured in the field.

4. The power supply shall continuously monitor field wires for earth ground conditions, and shall have the following LED indicators:

a. Ground Fault LED.

b. AC Power Fail LED.

c. NCA-2 on LED (4).

5. The main power supply shall operate on 120 VAC, 60 Hz, and shall provide power for the FACP or network node(s).

6. The main power supply shall provide a battery charger using dual rate charging techniques for fast battery recharge and be capable of charging batteries up to 60 AH for the NFS-640 and 200 AH for the NFS2-3030.

2.03 REMOTE ANNUNCIATORS

A. A non-networked fire alarm system annunciator is required when there is only one FACP in the system. Provide a Notifier Model LCD-80TM (CSFM7165-0028:0243), or LCD-160 (CSFM7120-0028:0227) alphanumeric display remote annunciator, or equal. A Network annunciator is required for any system that contains more than one fire alarm control panel (FACP) or network node. Provide a Notifier Model NCA-2 (CSFM7165-0028:0224, alphanumeric display remote annunciator, or equal. Display shall be back lit and be furnished with a maximum of 20 characters of 4 lines for the LCD-80, or 80TM and 40 characters on 16 lines for the LCD-160 or NCA-2. Provide the following functions:

1. Control switches for system acknowledge, signal silence and system reset via a touchpad.

2. Time and date display field.

3. Local piezo sounder with alarm or trouble resound.

4. On-line green LED (flashing).

5. Evacuation and drill switches, via a touchpad.

6. Pre-signal hold via a touchpad.

7. System test at control panel and CTR.

B. Following additional features shall be furnished:

1. Device Fire Annunciation.

2. Device Trouble Annunciation.

3. System Operation Annunciation.

4. "Power On" LED.

C. Typewritten operating instructions and a site map shall be posted adjacent to remote annunciator(s). The site map shall be sized and include designations and devices as described in paragraph 3.02 N. of this specification. Project site map shall depict fire alarm devices in the building(s) in which they are installed. The instruction and site map shall be mounted in suitable document frames and attached to the wall with a minimum of two screws each. Contractor's name and telephone number shall not be placed on either the instruction or the site map.

2.04 POWER SUPPLIES

A. Remote Notification Appliance Circuit (NAC) extender power supplies shall be Notifier No. FCPS-24S6 (CSFM 7315-0028:0225), or equal. Unit shall be furnished with main printed circuit board, transformers, lockable cabinet, and batteries. Unit shall be configured to drive 4 notification appliance circuits. The remote power supplies shall be configured with a monitor module to report trouble conditions to the controlling FACP via an SLC. Triggering of NAC inputs shall be directly controlled from the FACP without the use of addressable control or relay modules.

2.05 PERIPHERAL DEVICES AND EQUIPMENT

A. Manual Stations: Interior Use: Station shall be Notifier, Model No. BNG-1R (CSFM 7150-0028:0003) or equal, addressable semi-flush, non-breakable glass type. Station housing shall be fabricated of die-cast aluminum with reset lock and key. Provide an addressable monitor module Model No. FMM-101(A) (CSFM 7300-0028:0219) for each manual station.

B. Smoke Detectors: Smoke Detectors shall be Notifier Model No. FAPT-851 (CSFM 7272-0028:0206) or equal, addressable smoke detectors. Provide base Model No. B710LP. (CSFM 7300-0028:0173). Detector shall be microprocessor based, using a combination of photoelectric, and thermal sensing technologies. The smoke detector shall have its loop number and electronic address permanently and clearly labeled onto the device base using

a p-touch type labeling system. The label shall be visible without removing the detector head.

C. Projected Beam Infrared Type Smoke Detectors shall be Notifier Model No. FSB-200S (CSFM 7260-0028:0228), or equal, and shall consist of a transmitter / receiver unit and reflector to be used in accordance with manufacturers recommendations. Each detector shall include six user-selectable sensitivity levels. Alignment shall be achieved with a signal strength meter incorporated into the beam detector. The detector shall feature automatic detection and adjustment to the optimum level for the specific environment. Provide remote test stations with key lock for detectors, Notifier Model RTS-451KEY, or equal, located below ceiling.

D. Monitor Modules:

1. Monitor module shall be Notifier Model No. FMM-1(A) (CSFM 7300-0028:0219), or equal. Module shall connect a supervised zone of conventional initiating devices, N.O. dry contact devices, including four-wire smoke detectors, to one of SLC loops. Monitor module shall install in a four-inch square by 2 1/8-inch deep electrical box. The module shall have its loop number, electronic address, and function label on the front cover using a P-Touch type or equal labeling system.

2. Monitor module shall provide address-setting means using rotary decimal switches and shall store an internal type of device. An LED shall be provided which shall flash under normal conditions indicating that monitor module is operational and in regular communication with control panel.

E. Control Modules:

1. Control module shall be Notifier Model No. FCM-1 (CSFM 7300-0028:0219), or equal. Module shall be used to connect a conventional indicating appliance or MR type isolation relay to one of the SLC loops. Control module shall install in a standard four-inch square by 2 1/8-inch deep electrical box. Audio or visual or relay power shall be provided by a separate loop from main control panel or from supervised remote power supplies. The module shall have its loop number, electronic address, and function label on the front cover using a p-Touch type or equal labeling system. Provide Air Products PAM-3 Relay Model A77-716B (CSFM 7300-1004:0101) or equal power supervision relay to monitor 24 volt DC power.

2. Control module shall provide address-setting means using rotary decimal switches and shall store an internal identifying code which control panel shall use to identify type of device. An LED shall be provided which shall flash under normal conditions, indicating that control module is operational and in regular communication with control panel.

F. Relay Modules:

1. Relay Module shall be Notifier FRM-1(CSFM 7300-0028:0219) the module shall provide as a minimum one set of form “C” dry contacts and have its loop number, electronic address, and function labeled on the front cover using a P-Touch type labeling system.

2. Provide a buffer relay that is part of the control system if controlled circuit(s) exceeds the voltage or current rating of the relay module.

3. Relays used to interface control of other systems shall be electrically supervised and shall only be wired in a fail-safe mode of function during a power failure.

G. Isolator Modules:

1. Isolator module shall be Notifier, Model No. ISO-X, (CSFM 7165-0028:0243) or equal. Module shall isolate wire-to-wire circuits on an SLC loop in order to limit number of other modules or detectors that are incapacitated by short circuit fault. If a wire-to-wire short occurs, isolator shall automatically open-circuit SLC loop. When short is corrected, isolators shall automatically reconnect isolated section of SLC loop.

2. Isolator module shall not require address setting, although isolators will electrically reduce capacity of loop by two detectors or module addresses. Isolator module will install in a standard 4-inch deep electrical box. It shall include a single LED that shall flash to indicate that isolator is operational and shall illuminate steadily to indicate that a short has been detected and isolated.

H. Horns and Strobes: Horns and strobes shall be products of the same manufacturer. In order to establish a standard of quality, items are specified from the products manufactured by System Sensor, acceptable manufacturers are Honeywell, Wheelock Inc., Gentex or District approved equal. Addressable or multifunction two wire indicating (Audible or Visual) appliances shall not be acceptable.

1. Alarm horns shall be System Sensor Model No. HR (CSFM 7135-1653:0189) or equal, and shall be polarized and operated by 24 VDC. Entire unit shall be red finish. Horn assemblies shall be furnished with separate wire leads for in or out wiring for legs of associated signal circuits. T tapping of signal device conductors to signal circuit conductors is not permitted. Suitable gaskets shall be provided for weatherproof installation. Horns shall provide a minimum sound pressure level of 100 dB at 10 feet. Horns shall be mounted on manufacturer's recommended outlet boxes. Weatherproof horns shall be Model No. HRK (CSFM 7135-1653:0189); Provide a Model No. BBS-2 back box skirt on indoor surface mount outlet boxes.

2. Horn/strobe shall be wall mounted System Sensor Model No. P4R standard candela output or Model No. P4RH high candela output (CSFM 7135-1653:188); or equal. Horn/strobe shall operate on two separate two wire 24 VDC polarized circuits and shall be provided with a semi-flush mounting plate. Entire unit shall be red finish. Strobe light shall have a clear Lexan lens. The word "FIRE" shall be printed on the two sides of the strobe body. Horn shall provide a minimum sound output of 100 dB at 10 feet. The strobe shall provide a selectable minimum light intensity of 15, 30, 60, 75, 90, 110, 135, 150, or 185 Candela as indicated on Drawings to meet or exceed requirements of CBC, CHAPTER 11B AND ADAAG and UL 1971. Horn/Strobes shall be mounted on manufacturer recommended outlet boxes. Weather proof horn or strobe shall be model No. P4RK or Model No. P4RHK. Provide a model No. BBS-2 back box skirt on indoor surface mounted outlet boxes.

3. Strobe indicating appliances shall be System Sensor Model No. SR standard candela output or Model No. SRH high candela output (CSFM 7125-1653:0186), or equal. Devices shall be UL listed and shall be wall-mounted. Entire unit shall be red finish. Strobe light shall have a clear Lexan lens. The word "FIRE" shall be printed on two sides of the strobe body. Strobes shall meet CBC, CHAPTER 11B

AND ADAAG and UL 1971 requirements. The strobe shall provide a selectable minimum light intensity of 15, 30, 60, 75, 90, 110, 135, 150, or 185 Candela as indicated on the Drawings to meet or exceed requirements of CBC, CHAPTER 11B AND ADAAG and UL 1971. Strobes shall be mounted on manufacturer recommended outlet boxes. Weather proof strobe shall be model No. SRK or Model No. SRHK. Provide a model No. BBS-2 back box skirt on indoor outlet boxes.

4. Strobe synchronization modules if required shall be System Sensor Model No. MDL3R (CSFM 7300-1653:0202) or equal, to be installed in conjunction with two or more strobes located in same room or corridor or as indicated on Drawings. (Strobe synchronization modules must be compatible with installed strobes).

I. Electromagnetic Door Holder: Electromagnetic door holders shall be installed on doors as indicated on Drawings or as required. Electromagnetic Doors shall consist of a wall-mounted electromagnet and a door-mounted armature with an adjustable contact plate. Electromagnets shall provide a force of attraction of 35 pounds when energized and less than three pounds residual with power disconnected. Armature contact plates shall provide a horizontal adjustment of 25 degrees. The holding force of Electromagnetic Doors shall be totally electromagnetic and without the use of mechanical linkage or other moving parts. Electromagnetic Door Holders shall normally be energized, and a release shall be accomplished by interrupting the circuit. Door holders shall be Reliable Security Group DH Series (CSFM 3550-1039:0100) or equal. The door holder power supply shall be an Altronix Model AL400ULM (CSFM 7315-1335:0100) for three amp. Output, AL600ULM (CSFM 7315-1335:0100) for six amp output, AL1024ULM (CSFM 7315-1335:0100) for ten amp output. The power supply shall be equipped with a fail safe input trigger circuit and five individually protected outputs. (Electromagnetic Door holders shall not be powered by an FACP or remote NAC power supplies).

J. Bells: System Sensor Model No. SSM-24-10, or equal, with Weather proof back box No. WBB for installation with surface raceway. Bells shall be polarized and operated by 24 VDC. Bell shall be powered from FACP or Remote NAC power supply. When used as a notification appliance to indicate fire sprinkler water flow the bell shall be directly controlled by contacts in the associated flow switch. Addressable relays or control modules shall not be used to supervise sprinkler bells. Bell assemblies shall provide separate wire leads for in or out wiring for legs of associated signal circuits. Bells shall be vibrating type providing a minimum sound pressure level output of 84 - 87 dB at ten feet. Bells shall be ten inches in diameter, finished with baked-on red enamel paint, UL listed for fire alarm installation, and suitable for surface or semi-flush mounting. Provide a sign adjacent to the water flow bell with one inch tall and 3/8 inch stroke white lettering on a bright red background. The sign shall read: “NOTIFY FIRE DEPARTMENT WHEN ALARM SOUNDS”.

K. Water-flow Switches:

1. Water-flow switches shall be Potter Electric Model No. VSR-F (CSFM 7770-0328:0001) or equal. Vane-type water-flow switches shall be installed on system piping as designated on Drawings or as required. Detectors shall install on clear pipe spans of appropriate nominal size, either a vertical or horizontal run, at least six inches from fittings or valves which may change water direction, flow rate or pipe diameter, and not closer than 24 inches to valves or drains. Detector shall respond to water-flow in specified direction after a preset time delay that is field adjustable. Actuation mechanism shall include a polyethylene vane inserted through a hole in the pipe and connected by a mechanical linkage to delay

mechanism. Output shall consist of ten amps (dual SPDT switches form-C contacts). A conduit entrance for standard electrical conduit fittings shall be provided on detectors. Detectors shall be listed by UL for indoor or outdoor installation. No more than 18 inches of seal-tight flex may be used to connect the water flow or tamper switch to the site conduit system at any one location.

2. Sprinkler valve tamper switches shall be System Sensor Model No. OSY2 (CSFM 7770-1653:0118) for use with outside screw-and-yoke valves or System Sensor Model No. PIBV2 (CSFM 7770-1653:0118) for use with post indicating valves or equal. Supervisory switch shall be installed on valves as designated on Drawings or as required. Switches shall be installed to not interfere with normal valve operation and shall be adjusted to operate within two revolutions of valve control or when stem has moved no more than 1/5 of distance from its normal position. Mechanism shall be housed in a weatherproof die cast metal enclosure, also providing a 3/4 inch tapped conduit entrance to incorporate necessary facilities for attachment to valve. Switch mechanism shall be furnished with a minimum rated capacity of ten amps at 125 VAC and 2.5 amps at 24 VAC. Entire installed assembly shall be tamper-resistant. Tamper switches shall be UL listed. No more than 18 inches of seal-tight flex may be used to connect the water flow or tamper switch to the site conduit system at any one location.

L. The cable types listed below are based and specified on the recommendations of Notifier Fire Alarm Systems. If the submitted fire alarm system requires a different cable configuration with additional conductors, multi-conductor versus twisted pairs, etcetera than is specified above, request a substitution to supply and install the configuration of cables by the make and model of the fire alarm system that is to be installed.

1. Indoor Network and EVAC System Audio Output Circuit(s) applications shall be in conduit or in surface mounted raceway as indicated on drawings: West Penn No. D980, one pair 18 gage solid copper, unshielded, Copolene II insulated and PVC jacketed, or equal.

2. Indoor SLC applications in conduit or in surface mounted raceway where it is indicated on drawings: West Penn No. D990, one pair 16 gage solid copper, unshielded, Copolene II insulated and PVC jacketed, or equal.

3. Indoor Annunciator applications in conduit or in surface mounted raceway where it is indicated on drawings: West Penn No. D975, one pair 18 gage solid copper, shielded, Copolene II insulated and PVC jacketed, or equal.

4. Outdoor or Underground Network Applications: West Penn AQ224, two-conductor 18 gage stranded copper, unshielded, water-blocked construction and PVC insulated, or equal.

5. Outdoor or Underground SLC applications: West Penn AQ225, 2-conductor 16 gage, AQ226, 2 conductor 14 gage, or AQ227, 2 conductor 12 gage stranded copper, unshielded water-blocked construction and PVC insulated, or equal.

6. Outdoor or Underground Annunciator applications: West Penn AQ293, 2 conductors, 18 gage stranded copper, shielded water-blocked construction and PVC insulated, or equal.

M. Protective Covers

1. Provide protective covers for pull stations, smoke and heat detectors, and audible and visual devices located in areas occupied by students that can be subjected to vandalism such as gyms, restrooms, locker and shower rooms, and all hallways and corridors associated with these spaces. Installation of cover must not protrude over current ADA limitations.

PART 3 - EXECUTION

3.01 GENERAL

A. Fire alarm system shall not be used for any purpose other than fire alarm functions.

B. Fire alarm shall be interconnected but not limited to the following systems:

1. Systems required by code to be connected to the fire alarm systems shall be connected.

2. Public address system for disabling the manual and automatic bell or tone class passing signals. Manual and automatic class passing signals shall not be operable during alarm conditions.

3. Water based fire sprinkler systems.

C. Fire alarm system shall not be interconnected to any of the following:

1. Sump warning systems,

2. Carbon monoxide detection systems.

3. Methane gas detection systems.

4. Elevator car alarm bell circuit.

5. Other unrelated system.

3.02 SYSTEM INSTALLATION

A. Install required conductors to devices indicated on Drawings. Provide required conductor terminations to devices for a complete system to function as specified and indicated on Drawings. Refer to Section 26 0519: Low-Voltage Wire (600 Volt AC), for installation and color coding requirements.

B. Splices are not allowed in junction boxes. Terminations shall be in terminal cabinets or on equipment terminals.

C. Conductors shall be installed within conduits, boxes, and terminal cabinets in a totally enclosed installation. Furnish and install conductors required to connect incoming and outgoing circuits, including spare conductors, to terminal strips within terminal cabinets.

D. Wiring within equipment and terminal cabinets shall be installed to conform to contract documentation and NFPA 72 standards, and shall be terminated on terminal blocks having

terminals for required connections. Wiring shall be cabled, laced, and securely fastened in place so that no weight is imposed on equipment or terminals.

E. Install required terminal blocks within terminal cabinets. Terminal blocks shall be installed on inside back of cabinets only, not on side. Incoming wiring shall be terminated on the left side of terminal blocks; outgoing wiring shall be terminated on the right side of the terminal blocks.

F. Conductors shall be color-coded per specification section 26 0519 Low Voltage wires and tagged with code markers at terminal cabinets, and equipment. A wire index shall be typed and installed on terminal cabinet doors. Index shall be covered with clear plastic adhesive covers. Wiring shall be identified as to building and location of devices in the index.

G. Wiring within equipment and terminal cabinets shall be carefully strapped, and shall be formed in rectangular configuration. Wires shall be properly numbered in numerical order and shall maintain same number throughout the Project site.

H. Complete installation shall comply with local building codes and applicable provisions of the California Electrical Code, California Fire Code and the NFPA 72 National Fire Alarm Code.

I. Location of outlet boxes and equipment on Drawings is approximate, unless dimensions are indicated. Do not scale Drawings to determine locations and routing of conduits and outlet boxes. Location of outlet boxes and equipment shall conform to architectural features of the building and other Work already in place, and must be ascertained in the field before the start of Work.

J. Drawings generally indicate Work to be provided, but do not indicate all bends, transitions or special fittings required to clear beams, girders or other Work already in place. Investigate conditions where conduits are to be installed, and furnish and install required fittings.

K. Provide P-touch label of approximately one inch wide with red lettering for each initiating device that is hidden from view. Tags shall indicate the name and type of device: Heat Detector, or Duct Smoke Detector. Tags shall be permanently attached on access panel or t-bar grid which is used to access a hidden device.

L. Provide adjacent to each annunciator a neatly typewritten copy of the Fire Alarm Operating Instructions. The instructions shall reflect the installed and programmed features of the system. Instructions that include information on non-installed or programmed features will not be acceptable. The instructions shall be placed into a suitably sized dark colored wood or metal frame with a glass document face cover. The frame shall be attached to the wall with a minimum of two screws into the wall material with appropriate anchors.

M. Provide adjacent to each annunciator a neatly drawn site map showing rooms with designations and buildings with names as programmed into the system. This map shall be sized to allow (normal vision) reading of the designations, names etc. A map so reduced in size to the point of not being readable will not be acceptable. This map shall include symbols indicating the locations of installed fire sprinkler flow switches, riser shut off valves, post indicating valves and manual pull stations. Provide a symbol list on the map for the symbols used. The site map shall be placed into a suitably sized dark colored wood or metal frame with a glass document face cover. The frame shall be attached to the wall with a minimum of two screws into the wall material with the appropriate anchors.

3.03 SYSTEM PROGRAMMING

A. Programming shall be performed in accordance with the requirements set forth in this section – the local authority having jurisdiction and applicable codes. If a conflict arises or a clarification is required, the contractor shall contact the the Engineer for clarification

B. The following functions and features as required by the site or system configuration and installed peripheral equipment and systems shall be programmed into the fire alarm systems. The definition of programming shall include but not be limited to the use of a built in keyboard, the use of a connected PC with the appropriate software, dip or rotary switches, wiring or installable or removable jumpers as required or provided in the fire alarm equipment.

1. Signal Silence Switch Inhibit: The audible signal silence switch located on the remote fire alarm annunciator(s) or any fire alarm control panel(s) shall be programmed to not silence the audible or extinguish the visual alarm circuits during the first minute (60 seconds) of the fire alarm horn or strobe activation. Activation of this switch after the initial 60 seconds signaling shall silence only the audible signals. Enabling or disabling this feature shall be allowed only by authorized District maintenance personnel and shall be protected by a maintenance level password.

2. Audible and Visual Signal Auto Silencing Extinguishing: Audible coded signals and visual signals throughout the site, unless silenced by the above switch, shall be programmed to automatically self-silence or extinguish in no less than 5 minutes (300 seconds) and no more than 10 minutes (600 seconds). This feature shall not apply to the fire sprinkler water flow audible appliance.

3. Fire Sprinkler Water Flow Audible Appliance: The fire sprinkler water flow appliance (bell) shall not require any programming because of our requirement for this appliance to be directly controlled by a set of dry contacts within the associated sprinkler water flow switch(s). The 24 volt DC auxiliary power for the sprinkler water flow audible appliances shall be supplied by an FACP or a remote power supply. This audible appliance shall operate continuously during the detection of fire sprinkler water flow and shall not be coded in any manner nor silenced automatically by any FACP or manually by any user controls at any FACP or remote annunciator.

4. Fire Sprinkler Water Flow Switch: Fire sprinkler water flow switches shall be programmed in a manner that shall prevent the above Signal Silence Switch from silencing the audible coded signals or visual signals after the initiation of an alarm by a fire sprinkler flow switch.

5. Audible Notification Appliance Circuits: Audible notification appliance circuits shall be programmed to emulate the temporal code (ANSI S 3.41) from fire alarm audible appliances (horns). This coding shall originate and be controlled by a single coder residing within the FACP(s). The use of coders within remote power supplies either mounted adjacent to an FACP or at a remote location or directly by an audible notification appliance will not be permitted. Programmable audible notification appliances shall be configured to emulate a steady tone at approximately 1000 Hz. Audible notification appliance circuits shall be programmed to be silenced as described above. Notification appliance circuits throughout the site shall be activated by any alarm initiating device. Coded audible signals shall be controlled by a single synchronized FACP.

6. Visual Notification Appliance Circuits: Visual notification appliance circuits shall be programmed to provide steady non-coded power to the visual appliances (strobes). As required by code and the system configuration, a synchronization signal shall be superimposed onto the NAC by the FACP, a remote power supply or an add-on synchronization module. Visual notification appliance circuits shall be programmed to be extinguished as described above. Visual notification appliance circuits through out the site shall be activated by any alarm initiating device.

7. System Reset Button: The system reset button located on FACPs and remote annunciators in addition to resetting the fire alarm system and silencing or extinguishing notification appliances except for the sprinkler water flow appliances shall be programmed to reset analog and addressable smoke detectors, duct detectors, beam detectors and relays, addressable control modules and addressable relay modules used to interface to other systems and equipment. Each installed system reset button shall be programmed to operate as a "single point of reset" for the complete system.

8. Smoke Detector Maintenance Alert: Addressable smoke detectors shall be programmed with the capability of initiating a maintenance alert when any one detector becomes obscured by dust or any other contaminates at approximately 10 percent below the level of obstruction that would initiate an alarm.

9. Power Failure Reporting Time Delay: Main and remote NAC power supplies shall be programmed to delay the reporting of a site AC power failure for a minimum of 6 hours.

C. Device Descriptors:

1. Descriptors shall enable responding personnel to identify the location of a fire quickly and accurately, and shall indicate the status of emergency equipment or fire safety functions that might affect the safety of occupants. The minimum required information for devices intended to report smoke, fire, or fire sprinklers water flow include, but may not be limited to: Building, floor (if multiple floors exist in the building), room or space description, and device type and digital address (Smoke detector, Heat detector, Fire sprinkler water flow switch, etc).

   a. Building: The building must always be included in the descriptor, even if there is only one building one the site. Additional building(s) may be added at a later date creating the possibility of confusion by similar designated spaces, such as "Work room" or "Staff restroom" if more than one building has these similar designated spaces. The building designation in the descriptor must be what the site-based personnel call the building. The building should be provided with signage to aid fire department personnel in the identification of the building.

   b. Floor: In multi-floor buildings the floor designation (1st, 2nd, etc) must be included in the descriptor.

   c. Room Description: The room or space description must be unique. Using the same designation for multiple spaces, such as "Workroom", "Counselor's Office", or "Men's restroom", etc. is not acceptable. If, during a project, the room numbers or the use of the room changes then the room or space descriptor must be changed to agree with the change.

Proper signage should be provided for each space to aid fire department personnel in the identification of the room or space.

d. Device Type, Address and Compass Designations: The device type and digital address must be included with the descriptor, such as smoke detector or heat detector, etc. Some systems provide this information automatically in the descriptor. Compass designations, (N, S, E, and W) are required in spaces such as corridors where there are multiple detectors and this information would be helpful to responding fire department personnel in locating the device reporting alarm. It is not necessary to include compass designations in smaller spaces where there are multiple detectors located in close proximity to each other.

D. ACCEPTABLE ABBREVIATIONS

Rm.- Room	Bldg.- Building	Smk. - Smoke
Corr.- Corridor	Lby- Lobby	Asst. - Assistant
Eng.- English	N – North	Nrs. - Nurse
Flr.- Floor	S – South	Cnclr - Counselor
Ht.- Heat	E – East	Off. - Office
Lib.- Library	W – West	PE – Physical Education
Lkr. – Locker	Kit- Kitchen	RR- Rest Room
Stu Str – Student Store	Sci - Science	By = near
Stor Rm – Store Room	Café - Cafeteria	PM – Plant Manager
1st- First	2nd- Second	3rd- Third
Hopr Rm – Hopper Room	Det - Detector	Elev - Elevator
Prin – Principal	Blr Rm – Boiler Room	Conf – Conference
Park – Parking	Bsmt –Basement	MPR.- Multi-Purpose room

3.04 SYSTEM OPERATION

A. Unless otherwise specified, but not limited to actuation of manual stations, smoke detectors, heat detectors, linear heat or smoke detectors, or water-flow switches shall cause the following operations to occur, refer to Attachment B:

1. Activate audible circuits.

2. Actuate strobe units until the panel is reset or strobe circuit time-out.

3. Release magnetic door holders to doors to adjacent zones on the floor from which the alarm was initiated.

4. Activation of fire sprinkler system low-pressure switches, post indicator valve or tamper switches shall initiate a system supervisory alarm indication.

3.05 TESTING

A. A 48 hour notice shall be provided to the Project Inspector before final testing.

B. Testing of fire detection system shall be as required by the State Fire Marshal and local authorities having jurisdiction. Installer is responsible for identifying required testing, coordinating, scheduling, and conducting tests before Substantial Completion. Tests shall include the following:

1. Operation of signal-initiating devices (smoke detectors, heat detectors, pull stations etc.).

2. Operation of indicating devices (alarm horns, alarm bells and alarm strobes).

3. Operation of system features under normal operation.

4. Operation of system supervisory features.

5. Operation of system features on standby power, with primary power turned off.

6. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

7. Close sprinkler system flow valves and verify proper supervisory alarm at the FACP.

8. Verify activation of flow switches.

9. Open initiating device circuits and verify that trouble signal actuates.

10. Open signaling line circuits and verify that trouble signal actuates.

11. Open and short notification appliance circuits and verify that trouble signal actuates.

12. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.

13. Ground initiating device circuits and verify response of trouble signals.

14. Ground signaling line circuit and verify response of trouble signals.

15. Ground notification appliance circuit and verify response of trouble signals.

16. Check alert tone to alarm notification devices.

17. Check installation, supervision, and operation of intelligent smoke detectors.

18. Alarm conditions that the system is required to detect shall be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

19. When the system is equipped with optional features, consult the manufacturer manual to determine proper testing procedures.

C. Upon completion of installation of fire alarm equipment, provide to the OAR a signed, written statement confirming that fire alarm equipment was installed in accordance with the Specifications, Shop Drawings, instructions and directions provided by the manufacturer.

D. Demonstrate in presence of the Project Inspector that circuit and wiring tests are free of shorts and grounds and that installation performs as specified herein and within manufacturer's guidelines.

E. Software Modifications:

1. Provide the services of a factory trained and authorized technician to perform system software modification, upgrades or changes. Response time of the technician to the Project site shall not exceed 24 hours.

2. Provide hardware, software, programming tools, and documentation necessary to modify the fire alarm network on the Project site. Modification includes: addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modification on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being provided.

F. Complete the inspection and testing form as required by NFPA 72, and submit one copy of the completed form to the Engineer and Project Inspector.

3.06 SERVICE MANUALS

A. Deliver to OAR, three copies of the service manuals. Each manual shall include the following:

1. Installation manuals, programming manuals and user manual if applicable for every control panel, control panel power supply, FACP input or output or relay or control module, auxiliary power supply, installed annunciators, initiating and indicating devices and addressable monitor, relay and control modules. Catalog cut sheets are not acceptable.

2. A printed copy of the system configuration as programmed, including system labeling codes, and passwords.

3. An electronic copy on compact disk of the system configuration program

4. Final test report.

5. Detailed explanation of the operation of the system.

6. Instructions for routine maintenance.

7. Detailed wiring diagram for the connection of relays, addressable monitor, and control or relay modules as applied in the interfacing of peripheral systems or equipment to the fire alarm system. Updated shop drawings shall include revisions

made in the field via plan changes, RFIs, Field Change Directives, and any other construction change documents including interface details with ancillary systems.

8. An electronic copy (CD) of the posted site or fire alarm map in Auto-Cad and pdf formats.

9. Provide a CD ROM electronic copy of the updated system As-Built Drawings to the OAR, prepare this copy in the latest version of AutoCAD; along with the electronic copy provide a full size bond copy. Include one CD-ROM of the up-dated As-Built Drawings into each of the Service Manuals. CD and folded drawings shall be secured and inserted into the Service Manuals via a three-hole punched protective CD case and protective envelopes for the drawings.

10. Provide codes and passwords for fire alarm system at testing.

3.07 SPARE PARTS

A. The following new spare parts shall be furnished in unopened boxes:

1. One spare pull station including the associated monitor module (minimum one spare pull station per type).

2. One spare smoke detector.

3. One spare audible device.

4. One spare strobe device.

3.08 SYSTEM USER AND MAINTENANCE PERSONNEL TRAINING

A. Before Substantial Completion, provide one instruction period for the Project site based Owner operators and system users. The instruction period shall be scheduled and coordinated by the OAR.

B. Training materials and required deliverables shall be submitted to the OAR.

1. Prior to beginning the operational demonstration, notify Central monitoring Station that an instructional activity is beginning; inform them that it includes setting and resetting the system in test mode. After the demonstration is completed and the system restored, notify the Central Monitoring Station that the system has been restored and it is back on line for continuous monitoring.

C. User Instruction and Training

1. Before substantial completion and with a fully functional fire alarm system installed at the site, the contractor shall provide a minimum of four hours of user training for site based staff. The date and time for this training shall be coordinated by the project OAR.

D. Instruction period training for site based staff shall consist of the following:

1. Overview:

a. Explain the fire system is “addressable” which means every device-smoke detector, heat detector, sprinkler water flow switch, manual pull station, etc. has a unique address or identity. This makes it possible to positively identify the exact device causing an alarm, trouble or supervisory condition.

b. Explain the fire alarm control panel also controls the horns and strobes throughout the campus or building.

c. Explain that the fire alarm system is interconnected to various other systems and equipment through out the site such as:

1) Elevators to recall them to the main floor or to an alternate floor and as an option dependent circumstances turn off the power to the elevators.

2) Heating and air conditioning equipment to turn off fans and close dampers to stop the spread of smoke through out a building.

3) The class passing signaling system to disable the bells or tones to not accidentally signal students and staff to return to the buildings.

4) Magnetically held doors to close them to stop the spread of smoke.

5) To turn up house lighting in an occupied Auditorium or Multi-Purpose room to provide adequate egress lighting.

6) The Central and Autonomous PA systems to mute them during the sounding of the alarm signal.

d. Explain the fire system has a battery backup in case of power failure and that it will continue to function for a minimum of 24 hours after a total power failure.

e. Explain that the fire alarm system components and wiring are monitored to report a malfunction, damage or vandalism. When this occurs, a trouble indication will appear on the fire alarm annunciator and FACP and this indication will be transmitted to the central monitoring station.

f. Explain that other equipment and systems are monitored for abnormal conditions such as the fire sprinkler water being turned off. When this occurs, a supervisory condition is created. A supervisory indication will appear on the fire alarm annunciator and FACP and this indication will be transmitted to the central monitoring station.

g. Explain that the fire system in addition to notifying the occupants of a possible fire condition also transmits an alarm indication to the central monitoring station that will in turn notify and dispatch the local fire department to your site.

2. Basic:

a. Hand out the SYSTEM OPERATION instructions to attendees.

b. Point out the Fire Alarm Control Panel and have them observe the normal LED status (one green LED only should be on):

1) GREEN = Normal.

2) YELLOW = Trouble.

3) RED = ALARM.

c. Have the attendees observe the LCD display that should be indicating a SYSTEM NORMAL message.

d. Point out the Fire Alarm System Annunciator and have attendees observe the LCD display that should be indicating a SYSTEM NORMAL message.

3. Operation and Demonstration:

a. After putting the system or having someone put the system central station monitoring into the test mode demonstrate the following:

b. Activate a Manual Pull Station to demonstrate ALARM.

1) Demonstrate audible and visual notification appliances and if installed the voice evacuation signal announcement.

2) Demonstrate panel or annunciator sounder tone for ALARM.

3) Have staff SILENCE system.

4) Show LCD display and LED of alarm.

5) Demonstrate and have staff reset the manual pull station.

6) Have staff RESET fire system.

c. Activate Smoke Detector with canned smoke to demonstrate address identification:

1) Have staff SILENCE system.

2) Show LCD and display LED of ALARM.

3) Have staff RESET fire system.

d. Remove Smoke Detector to demonstrate SYSTEM TROUBLE.

1) Demonstrate panel or annunciator sounder tone for TROUBLE.

2) Have staff SILENCE system.

3) Show LCD display and LED of TROUBLE.

4) Replace the smoke detector.

5) Have staff RESET fire system.

e. Remove power to demonstrate function during power failure.

1) Have staff SILENCE system.

2) Show LCD display and LED of TROUBLE.

3) Activate Manual Pull station to demonstrate audible or visual functions in power failure mode.

4) Reset manual pull station.

5) Reset fire system.

6) If applicable, point out sprinkler riser and shut off valves.

7) Show location of a water flow switch.

8) Show location of a valve tamper switch.

9) Point out valves must always be OPEN or fully counter clock wise.

10) Point out PIV (Post Indicator Valves) if applicable.

11) Have water flow through the inspectors test valve and point out the ringing water flow bell.

12) After the horns are silenced by an assistant, show that the water flow bell is ringing continuously indicating water flow.

13) Have the assistant turn off the inspectors test valve to show that water flow alarm bell turns off.

14) Reset system.

15) Unlock and turn off a PIV or riser valve to show a supervisory condition.

16) Turn valve back on, lock the valve open and demonstrate the end of the indication of a supervisory condition.

4. Training documentation.

a. Insure fire panel is reset and indicates normal and central station monitoring is taken off of the test mode.

b. Have staff attendees sign off training sheet and provide a copy to the PROJECT INSPECTOR.

3.09 PROTECTION

A. Protect the Work of this section until Substantial Completion.

3.10 CLEANUP

A. Remove rubbish, debris, and waste materials and legally dispose of off Project site.

END OF SECTION 283100

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Clearing and grubbing.
   2. Stripping and stockpiling topsoil.
   3. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

A. Except materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

A. Prior to clearing or excavation operation, Contractor shall meet with the Owner to discuss any issues or potential problems that may arise from such activity.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Pothole for existing utilities in project areas.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited outside the limits of construction:

   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving"

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with Owner/utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner/Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's/Engineer's written permission.

C. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections and Section 024100 "Demolition, Salvage and Reconstruction".

3.4 CLEARING AND GRUBBING

A. Any trash, construction debris, concrete slabs, old pavement, landfill, and buried obstructions such as old foundations shall be traced to the limits and removed.

B. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Trees to be removed shall be marked and approved by the Owner prior to their removal.

2. Root balls shall be removed completely.

3. Remove obstructions, and debris to a minimum depth of 18 inches below exposed subgrade. Additional removal may be required to accommodate specific pipelines, structures, or other improvements.

C. Fill depressions caused by clearing and grubbing operations with structural fill material unless further excavation or earthwork is indicated.

1. Any excavations resulting from clearing and grubbing should be dish-shaped to the lowest depth of disturbance and backfilled with structural fill.

2. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove existing site gravel before stripping topsoil.

B. Strip topsoil to depth indicated in section 319000 "Geotechnical Report" in a manner to prevent intermingling with underlying subsoil or other waste materials. Excess trash, debris, concrete and buried obstructions shall be disposed of as indicated in the drawings and at the Engineer's discretion.

C. Organic stripping shall be hauled off site and shall not be used as fill.

D. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil and dispose offsite. Remove obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 311100 – FINISH GRADING AND LANDSCAPING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, services and equipment indicated on the Drawings and/or herein specified to complete all Finish Grading Work.

B. Finish grading shall consist of the final grading and shaping of all areas, except those areas under pavements, slabs and structures, to conform to lines, elevations and shapes as indicated on the Drawings.

1.2 DEFINITIONS

A. Subgrade: Subgrade shall mean surfaces upon which additional specified materials are to be placed, prepared or constructed.

B. Rough Grading: Rough grading shall mean the act that includes the spreading or placement of specified materials to the tolerances defined as final rough grade.

C. Final Rough Grade: Final rough grade shall mean the establishment of grades to a .15 foot plus or minus tolerance of grades required to accomplish the work described in other sections of the specifications on the drawings (i.e. landscape work, finish grading, concrete work, asphalt work, etc.)

D. Finish Grading: Finish grading shall mean the act that includes the spreading or placement of specified materials to establish the tolerances defined as final finish grade.

E. Final Finish Grade: Final finish grade shall mean the establishment of grades to a plus or minus tolerance of final grades as indicated on drawings. Tolerances are specified in applicable sections of the specifications (i.e. concrete, asphalt, finish grading, etc.).

1.3 RELATED WORK

A. Division One - General Requirements.

1.4 SUBMITTALS

A. Topsoil shall be subject to inspection and approval at the source of supply or upon delivery.

1.5 QUALITY ASSURANCE

A. All spot elevations to be staked for verification and approval by the Engineer.

B. Finish grade tolerance shall be within plus or minus 0.15 foot of final grades indicated on drawings.

C. Finished grades shall conform to shapes, spot elevations and contours, as indicated on drawings, with uniform levels or slopes between finished elevations or between finished elevations and existing elevations.

PART 2 - PRODUCTS

2.1 IMPORTED FILL MATERIALS

A. As required in Section 312000.

PART 3 - EXECUTION

3.1 GENERAL

A. Conduct work in an orderly manner and so as to not create a nuisance. Dirt shall not be permitted to accumulate on streets or sidewalks not to be washed into storm sewers.

B. Finished grades shall be established using materials as specified.

C. Mass Grading – Refer to Section 312000.

D. Finish grade tolerance shall be within plus or minus .15 foot of final grades indicated on drawings.

E. Finished grades shall conform to shapes, spot elevations and contours, as indicated on drawings, with uniform levels or slopes between finished elevations and existing elevations.

F. Finished grades shall be established to provide after settling, adequate drainage in a uniform way so no water pockets or ridges will be created.

3.2 FINISH GRADING

A. Fine grade all areas to a smooth, and uniform surface.

END OF SECTION

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Base Course for concrete walks, pavements, and roadway areas.
2. Structural fill for building pads, concrete structures and auxiliary structures.
3. Bedding course for pipe and utility trenches.
4. Drainage course.
5. Controlled Low Strength Material (CLSM) for structural fill applications.
6. Accessories.
7. Clearing and Grubbing.
8. Excavation for rough grading the site.
9. Excavation for structures.
10. Excavation for piping and utility trenches.
11. Installation and compaction requirements.

1.2 RELATED SECTIONS

A. 033000 “Cast-in-Place Concrete” for sheet vapor retarder requirements.

B. 319000 “Geotechnical Report” for additional information regarding existing soils and recommendations.

1.3 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.
3. Structural Backfill: Backfill placed below building pads, foundations, concrete structures and other areas where specified.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade and building slabs that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below base, drainage fill, drainage course, or topsoil materials.

J. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 QUALITY ASSURANCE

A. Contractor shall notify the Engineer of excavation plans a minimum of 48 hours in advance. The plan shall include a description of the location and extents of excavation.

1.5 INFORMATIONAL SUBMITTALS

A. Material test reports.

1.6 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: On-site soils (following clearing and grubbing) are suitable for use as compacted general fill, utility trench and structural backfill. Borrow materials (Imported Fill Materials) shall be similar to onsite soils or non-expansive, granular soil meeting USCS

classifications of SM, SP-SM, or SW-SM with a maximum rock size of 3 inches. All imported fill soil sources and material gradations shall be approved by the Engineer prior to the material being hauled to the site.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

2. Review Geotechnical Report included in section 319000 for additional information regarding unsuitable soils present on site.

D. Base Course: Base Course shall conform to CALTRANS Class 2 material requirements (3/4 inch maximum size).

E. Structural Fill: On-site soils or Imported fill material meeting the satisfactory soils requirements. Imported structural fill materials shall be subject to Engineer's approval prior to being hauled to the site.

F. Trench Backfill:
1. On-site soil free of debris, vegetation or other deleterious materials meeting the satisfactory soils requirements.
2. Trench backfill within roadways at a minimum shall conform to the Riverside County Standard No.818 – Utility Trench Backfill.

G. Bedding Course:
1. Pipe bedding/envelope material shall be a graded granular material.

Sieve Size	Percentage Passing
3/8-inch	100
No. 4	90-100
No. 50	10-40
No. 100	3-20
No. 200	0-15

2. Clean Concrete Sand (Sand Equivalent SE > 30)

H. Drainage Course:
1. For drainage course under building slabs and slabs on grade use 4-inch thick layer of clean concrete sand (sand equivalent SE>30) with 90-100% passing the #4 sieve.
2. In all other locations use a narrowly graded mixture of washed crushed stone, or crushed gravel; the gradation shall have the following gradation requirements:

Sieve Size	Percentage Passing
1-1/2-inch	100
3/4-inch	90-100
3/8-inch	40-100
No. 4	5-40
No. 8	0-5

2.2 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Where indicated in the drawings and when approved by the Engineer, Controlled Low Strength Material (CLSM) may be used as trench backfill, structural backfill, pipe bedding, or pipe backfill. CLSM shall consist of Portland cement, aggregates, water and fly ash. Chemical admixtures and other mineral admixtures may be used when approved by the Engineer.

B. The actual mix proportions and flow characteristics shall be determined by the producer of the CLSM to meet jobsite conditions and shall be approved by the Engineer. The mixture shall be workable and non-segregating.

C. The minimum compressive strength, unless noted otherwise shall be 1,200 psi.

2.3 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 CLEARING AND GRUBBING

A. All surface improvements, debris and/or vegetation including grass, trees, and weeds on the site should be removed from the construction area. Root balls shall be completely excavated. Organic stripping shall be hauled off from the site and shall not be used as fill. Any trash, construction debris, concrete slabs, old pavement, landfill, and buried obstructions such as old foundations and utility lines exposed should be traced to the limits of the foreign materials and removed. Any excavations resulting from site clearing and grubbing should be dish-shaped to the lowest depth of disturbance and backfilled with structural fill.

3.3 MASS GRADING

A. Prior to placement of any fill material, the surface 12 inches of soil should be removed, and the exposed surface should be uniformly moisture conditioned to a depth of 8 inches by discing and wetting to +/-2% of optimum moisture and re-compacted to at least 90% of ASTM D1557 maximum density. Native soils (following clearing and grubbing), free of organics, rubbish and any deleterious materials may be used for mass grading, placed in 6-inch maximum lifts, uniformly moisture conditioned to a depth of 8 inches by discing and wetting to +/-2% of optimum moisture and re-compacted to at least 90% of ASTM D1557 maximum density.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials

3.5 EXCAVATION FOR STRUCTURES

A. Excavations shall include the removal of all materials that would interfere with the proper execution of the Work. The removal of said materials shall conform to the lines and grades shown on the plans or ordered by the Engineer. The Contractor shall furnish, place and maintain all supports and shoring that may be required for safety of excavations and protection of adjacent structures and all pumping, ditching or other measures necessary for the removal or exclusion of water, including taking care of storm water, groundwater and wastewater reaching the site of the Work from any source so as to prevent damage to the Work or adjoining property. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable State, Federal or local requirements.

1. EXCAVATION FOR BUILDINGS AND CONCRETE STRUCTURES
    a. Building Pad Preparation –
        1) Unless otherwise noted, the following describes the required excavation and subgrade preparation for following structures:
            a) MBR Building
            b) Electrical Building
            c) Solids Handling Building
            d) Solar Drying Beds
            e) Solids Holding Tank Blowers Structure
            f) Solids Loading Facility
            g) Auxiliary Structures (Odor Control Facility Concrete Pads, Chemical Storage Concrete Pads, Emergency Generator Concrete Pads and any other structure not specifically noted in other sections).
        2) The existing surface soil within the building pad or concrete structure area(s) should be over-excavated to 24 inches below the lowest foundation grade extending two feet beyond all exterior wall/column lines (including

adjacent concreted areas). The exposed sub-grade should be scarified to a depth of 8 inches, uniformly moisture controlled to +/- 2% of optimum moisture, and re-compacted to at least 90% of ASTM D1557 maximum density.

b. Concrete Structure Preparation –

1) Unless otherwise noted, the following describes the required excavation and subgrade preparation for following structures:
   a) Headworks Channel
   b) Grit Trap Structure
   c) Fine Screens Structure
   d) Aeration Basins
   e) Equalization Basin
   f) Recycled Water Pump Station

2) The existing surface soil within the building pad or concrete structure area(s) should be over-excavated to 24-inches below the lowest foundation grade extending two feet beyond all exterior wall/column lines (including adjacent concreted areas). The exposed sub-grade should be scarified to a depth of 8 inches, uniformly moisture controlled to +/- 2% of optimum moisture by discing and wetting, and re-compacted to at least 90% of ASTM D1557 maximum density.

B. Over-excavations ordered by the Engineer that are not shown or specified and the resulting backfill will be paid for under a separate unit price bid item if such bid item has been established, otherwise payment will be made in accordance with a negotiated price. After the required excavation or over-excavation has been completed the exposed surface shall be scarified to a depth of 8 inches, brought to optimum moisture content and compacted in accordance with the requirements for the specific structure.

C. The Contractor shall keep separate and stockpile from required excavations all topsoil consisting of the top 8-inches of native material. The Contractor shall place and grade this topsoil material as the top 6-inches on areas requiring landscaping, if applicable, to the extent it remains available.

D. The Contractor shall notify the Engineer of the completion of any structural excavation and shall allow the Engineer at least 24-hours review period before the exposed foundation is scarified and compacted or is covered with any structural backfill materials.

E. The Contractor shall remove and dispose of all satisfactory native excess excavated material at a stockpile site identified in the drawings.

F. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade including any over excavation requirements. Place and compact structural fill and trim bottoms to required lines and grades to leave solid base to receive other work.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. All trench excavations should conform to CalOSHA requirements for Type C soil. The contractor is solely responsible for the safety of workers entering trenches. Temporary excavations with depths of 4 feet or less may be cut nearly vertical for short duration. Temporary shall be no steeper than 1.5:1 (H:V). Sandy soil slopes should be kept moist, but not saturated, to reduce the potential of raveling or sloughing.

B. Trench excavations deeper than 4 feet will require shoring or slope inclinations in conformance with CalOSHA regulations for Type C soil. Surcharge loads of stockpiled soil or construction materials should be set back from the top of the slope a minimum distance equal to the height of the slope. All permanent slopes should not be steeper the 3:1 to reduce wind and rain erosion. Protected slopes with ground cover may be as steep as 2:1. However, maintenance with motorized equipment may not be possible at his inclination.

C. Unless otherwise shown or ordered, excavation for pipelines and utilities shall be open-cut trenches. The bottom of the trench shall have a minimum width equal to the outside diameter of the pipe plus 24-inches. Trenches for pipelines smaller than 4 inches shall be excavated uniformly to the grade of the bottom of the pipe. Trenches for pipelines inches and larger, unless otherwise ordered by the Engineer, shall be excavated uniformly to the grade 6-inches below the grade of the outside bottom of the pipe. The over-excavation shall be replaced with gravel bedding material as specified herein for the particular type of pipe being installed. The pipe bedding shall be compacted by mechanical means suitable to the Engineer to ninety percent (90%) of relative density. The trench bottom shall be uniformly graded so that each pipe section when first laid will be continually in contact with the bedding along the entire length of the pipe. Where granular backfill under footings encases an underdrain piping system or has a thickness of 18-inches or greater or where shown on the Drawings, a layer of soil stabilization fabric shall be placed under the first horizontal layer of granular backfill. Soil stabilizer fabric shall be Mirafi 500 or equal. The sloping or vertical side slopes shall receive a layer of Mirafi 140 NL or equal.

D. The maximum amount of open trench permitted in any one location shall be the length necessary to accommodate the amount of pipe installed and backfilled in a single day. The Contractor shall make every reasonable effort to backfill all trenches at the end of each day. When this is not possible, barricades with warning lights meeting OSHA requirements shall be provided, set and maintained.

E. All pipeline and utility trench excavations shall be kept reasonably free from excess water during excavation, fine grading, pipe laying, and backfilling operations. Ground water shall be lowered to the extent necessary to keep the trench free from water and the trench bottom stable when the work within the trench is in progress. The Contractor shall provide and maintain at all times during construction ample means and equipment with which to properly and promptly remove and dispose of all water entering the excavation or other parts of the Work whether the water be surface water or underground water. The Contractor shall dispose of the water from the Work site in a suitable manner without damage to adjacent property.

F. When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be over-excavated beyond the depth shown or specified. Such over-excavation shall be to the depth ordered. The trench shall then be backfilled to the grade required. When the over-excavation ordered by the Engineer is 4-inches or greater below the limits shown, additional payment will be made to the Contractor for that portion of the Work which is located below said 4-inch distance. Said additional payment will be made under separate unit price bid items for over-excavation and bedding if such bid items have been established, otherwise payment will be made in accordance with a negotiated price.

G. The Contractor shall remove and dispose of all excess excavated material off-site.

H. Excavate trenches to indicated gradients, lines, depths, and elevations.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings with 1,200 psi CLSM.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 PIPE AND UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of water, mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Encase all piping that passes under footings with concrete, as detailed in the drawings. Where the depth from the bottom of the footing to the top of the encasement is less than the required depth of drainage course, the area shall be filled with concrete. Where the depth from the bottom of the footing to the top of the encasement is greater than the required depth of drainage course, the area shall be filled with structural fill and drainage course as required herein.

D. Backfill within roadways – Place in layers not more than 6 inches in thickness, uniformly moisture condition to +/-2% of optimum moisture and mechanically compact to a minimum of 90% of ASTM D1557 maximum dry density except for the 12 top inches of trench backfill which shall be compacted to at least 95%. Trench backfill shall only be placed and compacted after encapsulating the buried pipe with suitable bedding and pipe envelope material.

E. Place and compact initial backfill as required in the Specifications.

1. Backfill material shall not be dropped directly on the pipe or utility conduit.

2. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill as required in the Specifications to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

H. Pipe-zone and utility trench backfill material shall be spread and compacted in layers not to exceed 6-inches in thickness. Compaction shall be achieved using mechanical equipment. Flooding, ponding or jetting shall not be used for compaction unless otherwise approved by the Engineer. Pipe zone backfill material shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support. Piping shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfill operations. Trench zone backfill material shall be uniformly spread and mechanically compacted in layers not to exceed 12-inches in thickness. Moisture content shall be uniformly adjusted by wetting or drying as necessary.

I. Pipe zone including bedding compaction requirements shall be ninety-five percent (95%) of maximum density (ASTM D 1557).

J. Trench zone backfill using required excavated material shall be not less than eighty-five (85%) of maximum density except under paved areas, sidewalks, pipelines, utilities and structures which shall not be less than ninety-five percent (95%) of maximum density.

K. Aggregate base course materials shall be placed and compacted to not less than ninety-five percent (95%) of maximum density.

3.11 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in 8-inch maximum layers to required elevations using satisfactory native material or approved imported fill material. Compact to 90% of ASTM D1557 maximum density.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to moisture content indicated in the Geotechnical report.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS UNDER STRUCUTRES

A. Structural fill used below structures shall be placed in maximum 6-inch lifts, uniformly moisture conditioned +/-2% of optimum moisture and re-compacted to a minimum of 90% of ASTM D1557 maximum density.

B. Backfill and fill soil materials not placed below structures may be placed in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

C. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

D. Backfill shall not be dropped directly on or against any structure. Backfill shall not be placed around or upon any structure until the concrete has attained the required strength to support the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested for leaks and the structures are full of water while the backfill is being placed.

E. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations or may cause damage to the structure.

3.14 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.15 BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place base course under pavements and walks as follows:

1. Shape base course to required crown elevations and cross-slope grades.

2. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
3. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.16 VAPOR BARRIER UNDER BUILDING SLABS

A. Below MBR, Solids Handling and Electrical buildings, a sheet vapor retarder shall be installed and placed on top of properly prepared and compacted structural fill material free of mud, frost, snow or ice. The vapor retarder shall be protected from puncture.
   1. The vapor retarder shall extend a minimum of 12-inches into the footing excavation.
   2. Cover vapor retarder with 4 inches of clean concrete sand (sand equivalent SE>30).

3.17 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property at the Contractor’s expense.

3.20 DEWATERING

A. Prevent surface water and subsurface or ground water from flowing into trenches and excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well point, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

END OF SECTION 312000

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes construction dewatering.

1.3 PERFORMANCE REQUIREMENTS

A. The Contractor shall provide all labor, materials, and equipment necessary to dewater site excavations, in accordance with the requirement of the Contract Documents.

B. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
   1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
   4. Remove dewatering system if no longer needed.

C. To complete this Work, the Contractor shall secure any required Permits for Construction Dewatering and Hydrostatic Testing prior to commencing any dewatering work.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
   1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
   2. The geotechnical report is included elsewhere in section 319000.

C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
   1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
   2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
   1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
   1. Maintain free water level below bottom of excavation during construction.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 312319

SECTION 313232 – VERTICAL WICK DRAIN SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work consists of furnishing all necessary labor, equipment, and materials to install prefabricated vertical (wick) drains in the ground in accordance with the Plans and as specified herein.

1.2 REFERENCED CODES AND STANDARDS

ASTM D4716 Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

ASTM D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

ASTM D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles

ASTM D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity (2009)

ASTM D4751 Standard Test Method for Determining Apparent Opening Size (A.O.S.) of a Geotextile

1.3 QUALIFICATIONS

A. The Contractor shall have successfully completed a minimum of five wick drain installation projects in similar ground conditions and installed not less than 5,000,000 linear feet (1,525,000 linear m) of wick drain in the past five years. The Contractor shall have a minimum of five continuous years of wick drain installation experience.

1.4 SUBMITTALS

A. At least 30 days prior to the commencement of work the Contractor shall submit the following for review and approval:
   1. Experience. A list of a minimum of five (5) completed wick drain projects identified by name, location, project description, size, completion date, description of soil conditions, and contact person for the contracting organization.
   2. Manufacturer's wick drain material specifications identifying compliance with the requirements of Section 1.5 Materials.
   3. A 5-foot (1.5-m) long sample of the wick drain that will be installed. The sample shall be stamped or labeled by the manufacturer as being representative of the wick drain having the specified trade name.

4. Size, type, weight, maximum pushing force, vibratory energy (if applicable), and configuration of the installation rig in accordance with the requirements of Section 1.6 Equipment.
5. Dimensions and length of mandrel in accordance with the requirements of Section 1.6 Equipment.
6. Details of wick drain anchorage.
7. Detailed description of proposed installation methods, including methods for overcoming obstructions and methods for splicing wick drains.

1.5 MATERIALS

A. The prefabricated drains shall be of newly manufactured materials and consist of a polypropylene drainage core fully wrapped in non-woven geotextile. To ensure the fabric is durable to endure the installation, and to support the retention of the soil, without distress, or infiltration into the core, index tests on the fabric shall be tested independently from the core. Fabric from a master roll representative of the produced materials may be used for testing, if samples from the wick sample are too small for the required test. The tested results for the product shall meet the following minimum properties:

1. The assembled drains shall have the following minimum properties:

Total Discharge Capacity (@ 40 psi (275 kPa) and unit gradient)	1.5 gpm (5.7 lpm)	ASTM D4716

All drain materials shall be provided with non-woven geotextile meeting the following minimum properties:

Grab Tensile Strength	130 lbs (578 N)	ASTM D4632
Trapezoidal Tear	60 lbs (267 N)	ASTM D4533
Permittivity	0.7 sec-1	ASTM D4491
A.O.S.	70 sieve	ASTM D4751

The core shall have the following minimum properties:

Grab Tensile Strength	200 lbs (890 N)	ASTM D4632

B. Handling and storage of wick drain materials should follow the manufacturer's recommendations. During shipment and storage, the wick drain material shall be wrapped in a heavy-duty protective covering. The storage area shall be such that the wick drain material is protected from sunlight, mud, dirt, dust, debris, and detrimental substances. The drains shall be free of defects, rips, holes, or flaws. Damaged materials shall be replaced at the Contractor's expense.

C. All wick drain material delivered to the site shall be labeled or tagged for quality control purposes. Each roll shall be identified by lot or control numbers, individual roll number, date of manufacture, manufacturer, and product identification.

D. Wick drains shall be produced by a manufacturer with an in place quality control program which is monitored by an independent third party testing organization.

1.6 EQUIPMENT

A. The wick drains shall be installed with equipment which will causes a minimum of disturbance to the subsoil during the installation. The wick drains shall be installed with a sleeve or mandrel that will be advanced to the required depth using constant load, or constant rate of advancement methods. The mandrel shall be shaped to minimize disturbance to the subsoil, having a uniform and smooth exterior shape, without projections of any kind. The mandrel shall protect the wick drain material from tears, cuts and abrasions during installation and shall be withdrawn after the installation of the drain. The drain shall be installed with the approved anchorage to secure the bottom of the drain at the required depth at the time of mandrel removal. The cross sectional area of the mandrel shall not be greater than ten (10) square inches (6450 square mm). The wick drain installation unit shall be capable of applying a minimum downward force of 30,000 lbs (133 kN).

B. The use of falling weight impact hammers or jetting shall not be permitted for installation of the wick drains. Vibratory techniques may be used to penetrate stiff upper soil layers but may not be used once the mandrel has penetrated underlying compressible soils. Limited amounts of water may be permitted to facilitate anchorage or mandrel lubrication in highly plastic soils.

PART 2 - EXECUTION

2.1 CONSTRUCTION

A. Mark the proposed locations of the wick drains and take all reasonable precautions to preserve the markers. The locations of the markers shall not vary more than six (6) inches from the locations indicated on the Plans. Verify the location of all existing utilities and instrumentation devices prior to installing the wick drains.

B. 7Wick drains that deviate from the plan location by more than 6 inches (150 mm), or are damaged, or are improperly installed, will be rejected and no compensation will be allowed for any materials furnished or for any work performed on such wick drains. Replacement wick drains shall be offset from the location of the rejected wick drains as directed by the Engineer. The rejected wick drains shall remain in place.

C. Install the wick drains vertically to the depth(s), elevation(s), described levels, or to the firm substratum indicated in the Plans. Firm substratum is defined as the layer which resists further penetration at a reasonable effort. The Contractor shall provide the Engineer with a suitable means of verifying the plumbness of the mandrel and determining the tip elevation of the wick drain at any time. The equipment shall be carefully checked for plumbness and shall not deviate more than 0.25 inch per foot (20 mm per meter) from the vertical.

D. Splicing of the drain material shall be conducted in accordance with the manufacturer's recommendation to ensure structural integrity and hydraulic continuity of the drain. A maximum of one splice per drain will be permitted without specific permission from the Engineer.

E. Where obstructions or hard layers are present that prevent the installation of a wick drain, the Contractor will make two additional attempts to install a wick drain within 18 inches (450 mm) of the original location. If the drain can still not be installed, the initially intended drain location will be marked and designated for obstruction clearance by means of augering, drilling, punching, or spudding. Obstruction clearance in accordance with the approved procedure will be permitted to a maximum depth shown on the Plans, or as directed by the Engineer, and only where prior approval is given by the Engineer.

F. Where obstructions cannot be cleared by the methods listed in Section 2.1.E, the Engineer will determine if the wick drain is to be abandoned or installed to the required tip elevation.

G. Cut wick drains neatly at the upper end with a 4 to 8 inch (100 to 200 mm) length protruding above the working surface, or as necessary to connect to horizontal drains if utilized, as shown on the Plans.

2.2 METHOD OF MEASURMENT

A. Mobilization will be paid for by lump sum.

B. Wick drains will be measured and paid for by the linear foot installed, or abandoned as directed by the Engineer, for the full length of drain used, including drain used to fasten the anchor and the allowable length of wick drain protruding above the working surface.

C. Obstruction clearance will be measured and paid for as the number of linear feet from the working surface to the depth penetrated by the auger, spud, drill, or punch.

2.3 BASIS OF PAYMENT

A. Mobilization shall include the cost of furnishing of all equipment and materials necessary to properly execute the work.

B. The unit bid price for wick drains shall include the cost of survey and stakeout, installing wick drains, and furnishing all labor, tools, and incidentals necessary to complete the work.

C. The unit bid price for obstruction clearance shall include the cost of satisfactorily clearing obstructions to facilitate the installation of the wick drains, disposal of spoils, any required backfilling and furnishing all labor, tools, and incidentals necessary to complete the work.

END OF SECTION

SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 INFORMATIONAL SUBMITTALS

A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.

B. All excavations shall be adequately shored, braced, and sheeted to prevent earth movement or settlement. Existing structures, piping, duct bank/conduits, and other improvements that are to remain shall be fully protected from damage.

C. Proper shoring, sloping, sheeting, and bracing is required for all excavation where five feet in depth or more is required. A CALOSHA permit shall be obtained for trenches five feet or great in depth. A copy of this permit shall be supplied to the District with an additional copy kept at the job site at all times.

D. Contractor shall submit shoring, underpinning, and earth retention calculations and shop drawings to the District and Engineer for review and approval prior to commencing the work that requires said retention. All calculations and drawings shall be prepared under the supervision of and signed and stamped by a civil engineer licensed in California.

E. Contractor shall provide positive protection (mat/sheet coverings) for all excavation slopes to

protect slopes from instability and deterioration. This includes slopes on soil piles used for pre-loading and surcharging of areas.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Contractor shall coordinate all elements of the soil retention system with all surrounding utilities, structures, buildings, pipelines, and other improvements that are to remain and need to be protected. Shoring shall account for surcharge and other loading from adjacent footings and structures that are near excavation and require protection.

B. Prior to excavation or installation activities for elements of soil retaining systems, Contractor shall establish benchmarks around the perimeter of the area to be excavated. These marks shall be surveyed for vertical and horizontal movement at frequent intervals during actual excavation and construction work. Results of these surveys shall be submitted to Owner and Engineer for review.

C. A material testing laboratory (furnished by the District) shall review and monitor the excavation and soil retention systems. The Contractor shall provide, install and survey the vertical and horizontal movements of the top of the soil retention system as well as benchmarks placed adjacent to and for the retaining system. Results of these surveys will be reviewed by District and District's consultants.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Engineer.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.

END OF SECTION 315000

SECTION 316613 – AGGREGATE PIERS

PART 1 GENERAL

1.1 INTRODUCTION

A. **Aggregate piers** are columns of compacted aggregate used to reinforce the ground to increase bearing capacity and reduce settlement of a structure. They also can serve to increase slope stability. The piers can be constructed with a down-hole vibrator or a down-hole tamper.

B. **Suitable Soils**: Aggregate piers are typically utilized in fine grained soils that require additional reinforcement to increase bearing capacity and reduce settlement. For soils and groundwater conditions in which the predrilled hole remains open and stable, the aggregate can be placed by a loader into the open hole and compacted in lifts using either a down-hole vibrator or down-hole tamper. In unstable conditions, the hole stability must be maintained either with a bottom feed down-hole vibrator, casing if the tamper method is used, or other suitable method.

C. **Applications**: Aggregate piers are used in many applications. Examples of structures previously constructed on aggregate piers include: warehouses, multi-level condominiums, commercial retail or office space, wind turbine towers, roadway embankments, tanks, retaining structures, and parking structures.

1.2 INTENT

The intent of the aggregate piers specified herein is to provide soil reinforcement within the limits indicated on the project drawings to achieve the degree of improvement required to meet the performance criteria in Section 3.03 of these specifications.

1.3 STANDARDS AND REFERENCES

A. The most recent version of the following testing methods may be employed:

1. Spread Footing Load Testing (individual column, or column groups) D1194 modified for size.
2. Standard Test Method for Piles Under Static Axial Compressive Load

   ASTM D1143
3. Standard Test Method for Individual Piles Under Static Axial Tensile Load ASTM D3689

a.
b.

B. Reference documents as provided to the aggregate pier contractor shall include:

1. This specification.
2. Project drawings:

   Digester building and tank foundation plan, Area 69 in the plan set of drawings. Civil drawing 01C219.

3. Project geotechnical report.
4. Contract documents.

DEFINITIONS

A. Aggregate Piers are columns of compacted aggregate used to reinforce the ground to increase bearing capacity and reduce settlement of a structure. They also can serve to increase slope stability. The piers can be constructed with a down-hole vibrator or down-hole tamper.

1.4

B. Down-Hole Vibrators are specially designed, high-energy depth vibrators. The horizontal vibrations are created by a motor and eccentric weight located near the tip of the vibrator. Extension tubes are bolted to the vibrator to allow it to be lowered to the necessary treatment depth.

C. Bottom Feed Vibrators are down-hole vibrators which are equipped with a tremie pipe through which the aggregate is fed to the tip of the vibrator. This equipment is most often used in soil conditions which are too soft or cohesionless to remain open when pre-drilled.

D. Down-Hole Tampers are proprietary high-energy impact apparatus. The vertical tamping energy is provided by a hammer which is connected to a round, beveled tamper. The apparatus is lowered into a pre-drilled hole to the required treatment depth.

E. Field Quality Control Representative (FQCR): The individual given specific inspection tasks identified in this specification.

1.5 SCOPE OF WORK

A. The work shall consist of installation, monitoring and testing of the aggregate piers within the limits indicated on 01C219 and the foundation plan in Area 69 of the plan set of drawings to meet the performance criteria presented in Section 3.03 of these specifications.

B. In connection with the aggregate pier program, as shown on the drawings, the aggregate pier contractor shall provide all labor, materials, and equipment to accomplish the following items of work:

1. Pre-drilling of holes as necessary and disposal or stockpiling of all spoil.
2. Construction of the aggregate piers to the lines and grades on the construction drawing.

1.6

C. It shall be the aggregate pier contractor’s responsibility to determine and implement the systems and criteria to ensure that the specified performance is achieved.

SUBMITTALS

A. The following shall be submitted to the engineer by the aggregate pier contractor with the bid documents:

1. A list of at least five previously completed projects of similar scope and purpose for approval by the engineer. The list shall include a description of the project, relative size, and contact person with phone number.

B. The following shall be submitted to the engineer by the aggregate pier contractor three weeks prior to the start of the work:

1. Resumes of the management, supervisory, and key personnel.
2. A ground improvement design based on information contained in the project geotechnical report, prepared by an engineer licensed in the state of the work to be performed that demonstrates that the program achieves the specified performances criteria as specified in section 3.03 of these specifications.
3. A ground improvement QA plan, as detailed in section 3.04 of these specifications.
4. Work procedures and control criteria.
5. A shop drawing for review, indicating the spacing, location, and depth of the aggregate piers to achieve the criteria outlined in this specification.
6. Modulus test detail and setup to confirm that the installation procedure produces the pier modulus used in the design.

C. The following shall be submitted to the engineer by the aggregate pier contractor during the work:

1. Accurate daily records that include the type and size of compaction equipment and predrill auger diameter used, and, for each aggregate pier, the identification number and depth of the pier tip.
2. Any change in the subsurface conditions observed during the work.
3. The modulus test data, analysis of the data, and the concluding recommended design parameters, prepared by an engineer licensed in the state of the work.

D. The following shall be submitted to the engineer by the aggregate pier contractor after the work is completed:

1. A report documenting the observations and results of the tests. This report will certify that the bearing pressure has been achieved within settlement tolerances.
2. A warranty document good for one year.

1.7 QUALIFIED CONTRACTORS

1.8 The aggregate pier contractor shall meet the requirements stated in section 1.08 of these specifications. Hayward Baker Inc. is a pre-qualified contractor.

QUALITY ASSURANCE

A. The aggregate pier program shall be performed by a specialist aggregate pier contractor with at least five continuous years of documented experience in aggregate piers.

B. The aggregate pier contractor shall provide experienced management, supervisory and key personnel to implement the aggregate pier program.

C. As detailed in Section 1.06, the aggregate pier contractor shall provide evidence of aggregate pier project experience.

D. The engineer (FQCR) will ensure that procedures and documentation conform to these specifications.

EQUIPMENT AND MATERIALS

EQUIPMENT

PART 2

2.1

A. Down-Hole Vibrator

1. Should the aggregate pier contractor use a down-hole vibrator, the vibrator shall be capable of providing at least 80 HP of rated energy and a centrifugal force of 15 tons. An appropriate metering device should be provided at such a location that inspection of amperage increase may be verified during the operation of the equipment. The metering device may be an ammeter directly indicating the performance of the vibrator tip. Complete equipment specifications should be submitted to the Engineer prior to commencement of the fieldwork.

B. Down-Hole Tamper

1. Should the aggregate pier contractor use a down-hole tamper, the tamper shall have a diameter that is at least 90% of the pre-drilled hole diameter, have beveled sides, and be long enough to reach the full depth of the pre-drilled hole. The tamper shall have a minimum Construction Industry Manufacturer's Association (CIMA) rating of 1,225 ft-lb and shall apply direct downward impact energy to each lift of aggregate. A minimum tamper energy level of 490,000 ft-lbs. of force per minute shall be applied by the energy source.

2.2

BACKFILL MATERIALS

A. Down-Hole Vibrator Method: The backfill aggregate should consist of hard, angular to sub-angular durable rock fragments, with the majority of particles in the range of 1/8th inch to 1-1/2 inches such as ASTM C33 size No. 57 or shall be other graded aggregate selected by the installer and successfully used in the modulus test.

B. Down-Hole Tamper Method:

1. Aggregate used for piers constructed above the water table shall be Type I, Grade B in accordance with ASTM D1241, or shall be other graded aggregate selected by the installer and successfully used in the modulus test.

2. For aggregate used for piers constructed below the water table, the gradation shall be the same as Type I Grade B, except that particles passing the number 40 sieve shall be

eliminated. Alternatively, No. 57 stone or other stone selected by the installer may be used.

3. When type I Grade B material is used, potable water or other suitable source shall be used to increase the aggregate moisture content when required.

EXECUTION

SITE INSPECTION

PART 3

3.1 A. If an adjacent building is within 15 ft of the aggregate pier work area, a relevant building examination shall be performed prior to initiating work to document preexisting cracks/damage. The building must also be monitored for movement during any work within 15 ft of the structure. The work shall be stopped, and the engineer notified if any building settlement is observed.

AGGREGATE PIER CONSTRUCTION

The general procedures are as follows:

3.2

A. Stable Ground Conditions: The following general procedures shall be followed when the pre-drilled hole remains open during construction.

1. Pre-drilling to the design depth will be performed with an auger diameter equal to the finished column diameter.
2. Down-Hole Vibrator Method: The quantity of aggregate initially added shall be such that the vibrator tip is able to penetrate to within 12 inches of the design depth. The vibrator will be raised and lowered repeatedly, such that on each re-penetration, the tip of the vibrator advances to within 12 inches of the previous penetration depth.
3. Down-Hole Tamper Method: Following placement of the first 12-inch lift of aggregate, the tamper is to be lowered to the top of the aggregate and activated. The full energy of the impactor and weight of the excavator shall be used for at least 30 seconds per lift, and subsequent lifts shall not exceed 12 inches in thickness.
4. The aggregate shall be removed and replaced with fresh aggregate if cave-ins occur during the aggregate placement such that the volume of caved-in soil is greater than 10 percent of the aggregate being compacted.

B. Unstable Ground Conditions: The following general procedures will be followed when a pre-drilled hole will not remain open before or during pier construction.

1. Down-Hole Vibrator Method: If the hole will remain temporarily stable, the hole may be filled with aggregate to a level above the instability as long as the vibrator is still able to penetrate to within 1 foot of the pre-drilled depth. If the hole will not remain temporarily stable, a Bottom Feed Down-Hole vibrator may be used.
2. Down-Hole Tamper Method: A casing with a minimum outside diameter equal to 100% of the pier diameter is advanced to the full treatment depth. The first 12-inch lift of aggregate will be placed, and the tamper lowered to the top of the aggregate. The full energy of the impactor and weight of the excavator shall be used for at least 30 seconds per lift, and subsequent lifts shall not exceed 12 inches in thickness. The casing is

extracted after each lift is compacted with the bottom of the casing always maintained below the top of the aggregate.

C. Obstructions: Aggregate piers shall be constructed within 6 inches of the design location. Obstructions encountered during excavation or drilling that will prevent installation of the aggregate piers to design depth, or cause the aggregate pier to stray from its specified location during installation shall be removed. To the extent the obstructions are shown in the geotechnical report, removal of obstructions shall be performed at no additional cost to the owner.

Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, utility lines, etc., that prevent installing the aggregate piers to the required depth, or cause the aggregate pier to drift from the required locations. Dense natural rock or weathered rock shall not be deemed obstructions, and piers may be terminated short of design lengths on such materials. The aggregate pier design engineer shall be notified within 24 hours to verify that the short piers are acceptable.

3.3 PERFORMANCE CRITERIA

1. Construct appropriate aggregate piers with granular backfill material beneath all column foundations and load-bearing wall foundations to provide the following criteria upon completion:

   a. An allowable soil bearing capacity of 5,000 pounds per square foot (psf) with a maximum total settlement of 1 inches and a maximum differential settlement of 0.003 times the distance between adjacent columns.

2. Aggregate piers should be constructed to a depth sufficient to satisfy the settlement criteria above. A modulus test shall be performed to verify the parameter values selected for the pier aggregate.

3.4 FIELD QUALITY ASSURANCE

A. Inspections

1. All aggregate pier operations shall be performed under the observation and documentation of the FQCR.
2. Monitoring and logging of aggregate pier operations for both test and production work shall be done by the FQCR.
3. The FQCR will provide site observation and documentation to ensure performance of the aggregate pier work. This inspection may include the following: recording of predrill hole depth, observance of the aggregate pier contractor's procedures, and recording of compaction energy information.
4. A sample of the backfill material should be submitted to the Engineer for a grain size distribution analysis to establish the suitability, the cost of which will be borne by the owner. Certification of grain size distribution provided by the quarry may be submitted in lieu of a sample.
5. The foundation bearing surface shall be compacted and firm prior to the construction of the foundation.

B. Modulus Test

Testing to determine specification compliance will be provided by the aggregate pier contractor, and will consist of at least one modulus test of an aggregate pier.

The results of the Modulus Test shall meet the following criteria to pass:

1. The geotechnical engineer shall approve of the location of the Modulus Test.
2. Deflections of the top of the test pier shall be measured by a suitable method.
3. Deflections at the bottom of the test pier shall be measured by means of a telltale installed at the bottom of the test aggregate pier. Performance will be deemed acceptable when, at the specified design stress, deflection at the bottom of the pier does not exceed 20% of the deflection at the top of the pier.
4. Load increments, decrements, and duration shall be determined using ASTM D1143 as general guidelines.
5. Surficial disturbance shall be compensated for by applying a seating load equal to 5% of the total load to the loaded steel plate before applying load increments.
6. The modulus testing shall be performed as described in the Design Submittal.

UPLIFT TEST

3.5

A. In addition to specifications within this section, ASTM D3689 shall be the general guide in establishing uplift load test procedures. The uplift load test will be performed as described in the Design Submittal.

B. The Geotechnical Engineer shall approve the site location of the uplift load test.

C. Verification that the design of the aggregate pier system is in accordance with the performance observed during the uplift load test shall be attained through information acquired during the uplift load test.

3.6

REJECTION OF AGGREGATE PIERS

A. If an aggregate pier is installed in an incorrect location or exceeds the specified tolerances, the aggregate pier contractor shall replace the pier. Pier replacement may be avoided if alternate remedial procedures are approved by the Designer. Unless the rejection is caused by obstruction, refusal in rock or dense soil or errors in the project drawings, the cost of all labor and material required for the replacement shall not be the responsibility of the Owner.

3.7

EXCAVATION OF PIER TOPS, AND UTILITIES

A. Excavations conducted after aggregate pier installation shall be performed such that the horizontal distance between the edge of any aggregate pier and the nearest edge of the excavation is such that the pier is not affected. If installed aggregate piers are located within the zone of influence of excavation, the General Contractor and Engineer shall collaborate to develop solutions to excavation or construction methods that will avoid detrimental impact to the installed aggregate piers.

Potential solutions include:

1. Constructing affected portions of the aggregate piers with a cement-treated aggregate.

2. Placing and compacting select aggregate in excavation zones that have disrupted the structural continuity of the aggregate pier. Operations, materials, equipment, and testing shall adhere to the following requirements:

a. Gradation of the aggregate shall meet specifications drafted by the Engineer.

b. The impact compaction equipment shall be motorized, and the procedure shall ensure controlled placement of the aggregate.

c. Compaction of the aggregate shall reach 95% of the maximum dry density. The maximum dry density shall be determined by the modified Proctor method (ASTM D1557).

d. Placement and compaction shall be observed on-site by personnel from an independent testing firm. The independent testing firm shall also execute density testing on-site, and submit results of the density testing to the General Contractor and Engineer. Scheduling of excavation, placement, and compaction shall be determined by the General Contractor. The General Contractor will provide the aforementioned schedule to the independent testing firm and make arrangements for observation of placement and compaction, and execution of density testing.

BOTTOMS OF FOOTINGS

3.8

A. Prior to placement of structural concrete, aggregate pier tops shall be excavated in a manner that will prevent the soil matrix surrounding the aggregate piers from softening, and ensure that a direct connection between the aggregate pier and concrete footing will be achieved.

B. The following excavation procedures shall be followed:

1. Over-excavation below the bottom of the footing shall be backfilled with the material and procedures described in 3.07A.2.

2. Aggregate pier tops and footing bearing soils shall be compacted with a motorized impact compactor. Tampers of the “sled” variety shall not be employed. The entire surface area of the footing bottom shall be compacted to ensure that any loose surface soil and/or loose surface aggregate is densified.

3. Footing concrete shall be placed immediately following approval of the completed footing excavation work. It is ideal that approval of the excavation work be stated on the same day that the excavation takes place. If the bearing soils are expansive or sensitive, it is imperative that the footing concrete be placed on the same day that the excavation takes place.

4. If footing concrete cannot be placed on the same day that excavation takes place, a minimum 3-inch-thick mud mat shall be placed immediately following approval of the footing excavation.

C. The following criteria shall apply, and shall be verified by the FQCR in a written report:

1. The footing excavation has been kept free of water since completion of excavation work. This will ensure that the unconfined matrix soil surrounding the aggregate piers has not

been softened. Softening of the matrix soil may negatively impact the load bearing capability of the reinforced subgrade.

2. That at each footing location, all aggregate piers installed have been fully exposed within the limits of the footing excavation.

3. That the following specified procedures required immediately prior to construction of the footings have been followed:

a. Inspection of each aggregate pier top after exposure by the footing excavation.
b. Recompaction, as required, of aggregate pier tops by mechanical impact compaction equipment.
c. Recompaction of aggregate pier tops that have or may have been disturbed by footing excavation or other actions, to the satisfaction of the FQCR.

4. Assurance that no excavation has been made within a distance that will affect any completed pier, without being approved in writing by the aggregate pier contractor and Engineer.

RESTRICTIONS

3.9 A. Aggregate pier construction is typically performed under the site grading permit. The Owner or General Contractor shall be responsible for obtaining any state and local permits (if required) and conforming to all state and local regulations.

B. The Owner will be responsible for the precise delineation of all above and below ground utilities and obstructions.

C. The following shall also be listed within this section when applicable:

1. Environmental restrictions.
2. Work boundaries.
3. Hours for construction.

3.10

FOOTING SUBGRADE PREPARATION

A. The footing bearing surface shall be free of all water and compacted prior to placement of any reinforcement. Compaction can be by any heavy tamping type compaction equipment designed for compaction in small spaces. Reinforcement and concrete placement shall be placed in a timely manner so that no degradation of the bearing surface occurs.

END OF SECTION 316113

SECTION 319000 – GEOTECHNICAL REPORT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the Geotechnical Report prepared for this project (see Appendix A).

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold milling of existing asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt overlay.
5. Asphalt curbs.

B. Related Requirements:

1. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each paving material.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the local standards where the project is located for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Asphalt and Aggregate thickness shall be as indicated in the drawings.

2.2 AGGREGATES

A. Aggregate base shall conform to Caltrans Class 2 (maximum ¾"), compacted to a minimum of 95% of maximum dry density (ASTM D1557).

B. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

D. Mineral Filler: ASTM D 242/D 242M, rock or slag dust, hydraulic cement, or other inert material.

2.3 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320.

B. Asphaltic concrete shall be Caltrans, Type B, ¾ inch maximum medium grading.

C. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: Materials for aggregate base shall be as specified in the Geotechnical Report. Aggregate base shall be provided where shown and to the thickness shown. Imported aggregate bases shall be delivered to the job site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. The base material shall be spread and compacted in layers of equal thickness and the maximum compacted thickness of any one layer shall not exceed 6-inches. The relative compaction of each layer of aggregate base shall not be less than ninety-five percent (95%) of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, and smooth to grade.

PART 3 - EXECUTION

3.1 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 3 inches.
2. Patch surface depressions deeper than 1 inch after milling, before wearing course is laid.

3.2 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. Any soft pockets shall be repaired.

C. Place pavements on 12 inches of moisture conditioned (at least 2% over optimum) subgrade (native soil) compacted to a minimum of 95% of the maximum dry density determined by ASTM D1557, or the governing agency requirements.

D. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Spread mix at a minimum temperature of 250 deg F.
2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F, or during unsuitable weather as determined by the Engineer.

C. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

D. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Compact to a minimum of 95% of the 50 blow Marshall Density (ASTM D1559).

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F.

1. Asphalt Mix: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.8 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated in Drawings within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Curbs and gutters.
   2. Cross gutters.
   3. Walks.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Cast-In-Place Concrete. Section 033000

B. Joints In Concrete. Section 032900

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

D. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

E. Deformed-Steel Wire: ASTM A 496/A 496M.

F. Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project, see Section 033000 “Cast-in-Place Concrete”.

B. Normal-Weight Aggregates: ASTM C 33, uniformly graded. Provide aggregates from a single source.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: All concrete shall contain five percent (5%), plus or minus one percent (1%) entrained air of evenly dispersed air bubbles at the time of placement. The air-entraining agent shall contain no chloride and conform to ASTM C 260, or U.S. Army Corps of Engineers Specifications CRD-C13. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. The Engineer, or Owner and his duly authorized representatives reserve the right, at any time, to sample and test the air-entraining agent or the air content of concrete received on the job by the Contractor. Air entrainment in the concrete shall be tested by ASTM C 138, ASTM C 231 or ASTM C 173. If any sample tested does not have the specified air content, a second test shall be performed. If the second test does not meet the specified air content, the concrete represented by the test shall be removed from the job.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

F. Water: Complying with ASTM C 94/C 94M.

2.3 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.4 RELATED MATERIALS

A. Joint Fillers: ASTM D 1752, cork or self-expanding cork in preformed strips.

2.5 PAVEMENT MARKINGS

A. Pavement-Markings: In accordance with Section 321723 – Pavement Markings.

2.6 WHEEL STOPS

A. Wheel Stops: Precast, air-entrained concrete.

1. Color: Gray.
2. Dowels: Galvanized steel, 3/4 inch in diameter, 10-inch minimum length.
3. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:

1. Compressive Strength (28 Days): 4000 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 3-inches, plus ½-inches or minus 1 inch.
4. Air Content: 5 percent plus or minus 1.0 percent.

B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

C. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate.

D. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION AND SURFACE PREPARATION

A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving:

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

B. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed paving surface with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.7 CURING AND DAMP-PROOFING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these.

3.8 CURING IN COLD WEATHER

A. Comply with ACI 306.1 for cold-weather protection.

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/2 inch.
4. Joint Spacing: 3 inches.
5. Contraction Joint Depth: Plus 1/4 inch, no minus.
6. Joint Width: Plus 1/8 inch, no minus.

3.10 PAVEMENT MARKING

A. Allow concrete paving to cure for a minimum of fourteen (14) days and be dry before starting pavement marking.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 WHEEL STOPS

A. Set and level bumpers on pavement with an adhesive consisting of asphaltic emulsion, and anchor to the pavement with two No.5 by 2-foot (0.6 m) deformed bars. Apply the asphaltic emulsion in accordance with CALTRANS Section 94-1.02.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.

B. The repair of holes left by rock pockets, penetrations, tie rods or other reasons will require the use of non-shrink, non-metallic grout metal.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321723 – PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:
   1. Drawings and general provisions of the Subcontract apply to this Section.
   2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:
   1. Pavement striping and markings.
   2. Signs.
   3. Pavement markers.

C. Related Sections:
   1. Division 01 Section "General Requirements."
   2. Division 32 Section "Asphalt Paving".
   3. Division 32 Section "Concrete Paving".

1.2 REFERENCES

A. General:
   1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
   2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
   3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.
      State of California, Department of Transportation (CALTRANS)

B. State of California - California Department of Transportation (CALTRANS):
   1. Standard Specifications:
      a. Sec 56. Signs
      b. Sec 85. Pavement Markers
      c. Sec 94. Asphaltic Emulsions

PART 2 - PRODUCTS

2.1 PAINT

A. White Traffic Paint: DuPont #LF32M30P, Hawkins-Hawkins Co. #V10-31, or equal.

B. Yellow Traffic Paint: DuPont #112-8049, Hawkins-Hawkins Co. #V10-32, or equal.

C. Blue Paint (Handicapped Areas): DuPont "Precaution Blue" #326Y23665, Hawkins-Hawkins Co. #V10C-1865, or equal.

D. Red Curb Paint: DuPont #LC64M30P, Hawkins-Hawkins Co. V10C-23, or equal.

2.2 SIGNS

A. Signs:
   1. Adhere to Local Jurisdiction
   2. International Handicap Sign and Symbol: adhere to Local Jurisdiction.

B. Substitutions: Under provisions of Division 01.

2.3 PAVEMENT MARKERS

A. Amber Bi-Directional Pavement Markers: Reflective type; Hawkins-Hawkins Co. #V16C-D, Westway, or equal.

B. Amber Mono-Directional Pavement Markers: Reflective type; Hawkins-Hawkins Co. #V16C-H, Zumar model 88B type H, or equal.

C. Clear Pavement Markers: Center-mount plastic reflectors, 3-1/4 inch diameter, type GM-75; Safeway Sign Co., Western Highway Products, or equal.

PART 3 - EXECUTION

3.1 STRIPING AND MARKINGS

A. Mark and stripe uniformly in design, position, and application.

B. Do not apply paint to the paved surface within 24 hours after paving.

C. Apply two coats of paint in accordance with manufacturer's directions. Protect adjacent surfaces against splatter or stains.

3.2 SIGNS AND GUIDE MARKERS

A. Install signs and guide markers at locations indicated on the Drawings in accordance with CALTRANS Section 56.

3.3 PAVEMENT MARKERS

A. Install pavement markers at locations indicated on the Drawings in accordance with CALTRANS Section 85.

END OF SECTION 321723

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Fence, framework, fabric, and accessories.
   2. Excavation for post bases and concrete foundations for posts.
   3. Manual gates and related hardware.

B. Description:
   1. All work on the project will take place on the perimeter of the existing site and will include replacing and connecting into existing fencing. This section is solely for chain link fence for fencing specifically indicated as “Chain Link Fencing” in the design drawings. Other fencing types (as indicated in the drawings) must match existing fencing in size, type and materials of construction as detailed in the Civil Details of Volume 4A. Refer to civil grading and site plans in Volume 4A for required locations of chain link and specialty fencing.

1.2 REFERNCES

A. ASTM A36 Standard Specification for Carbon Structural Steel

B. ASTM A121 Standard Specification for Metallic-Coated Carbon Steel Barbed Wire

C. ASTM A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel products.

D. ASTM A 153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel products.

E. ASTM A392 Standard Specification for Zinc-Coated Steel Chain-Link Fabric

F. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-dip Galvanized Coatings

G. ASTM A817 Standard Specification for Metallic-Coated Steel Wire for Chain Link Fence Fabric and Marcelled Tension Wire

H. ASTM A824 Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link

I. ASTM B221 Standard Specification for Aluminum and Aluminum Alloy Bars, Rods, Wire Profiles and Tubes

J. ASTM F552 Standard Terminology Relating to Chain Link Fencing

K. ASTM F567 Standard Practice for Installation of Chain Link Fence

L. ASTM F626 Standard Specification for Fence Fittings

M. ASTM F900 Standard Specification for Industrial and Commercial Swing Gates

N. ASTM F1043 Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework

O. ASTM F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

P. ASTM F1184 Standard Specification for Industrial and Commercial Horizontal Slide Gates

Q. ASTM F1910 Standard Specification for Long Barbed Tape Obstacles

R. ASTM F1911 Standard Practice for Installation of Barbed Tape

1.3 PERFORMANCE REQUIRMENTS

A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer.

B. Structural Performance: Chain-link fence and gate framework shall with stand the effects of gravity and wind loads in accordance with ASCE 7.

1. Minimum post size: Determine according to ASTM F1043 for framework up to 12 feet high, and post sizing not to exceed 10 feet.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For chain-link fences and gate framework provide wind loading analysis data in accordance with ASCE 7 signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of chain-link fence and gate, from manufacturer.

B. Product Test Reports: For framing strength according to ASTM F 1043.

C. Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company having a minimum 5 years of experience specializing in manufacturing of chain link fence products.

B. Fence Contractor: Contractor having 5 years of experience installing similar projects in accordance with ASTM F567.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Storage and handling: Unload, store, and protect materials such that they are not damaged.

1.9 PROJECT CONDITIONS

A. Field measurements:
   1. Verify actual field distances so that post spacing can be made uniform.
   2. Verify and coordinate gate openings and column distances for entrances.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

   1. Failures include, but are not limited to, deterioration of metals, metal finishes, and other materials beyond normal weathering.
   2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS;

A. Chain link fence and gates: One of the following or equal:
   1. Master-Halco

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:

   1. Fabric Height: As indicated on Drawings.
   2. Steel Wire Fabric: 9-gauge wire.

      a. Mesh Size: 2-1/8 inches.

b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied before weaving.

3. Selvage: Twisted top and knuckled bottom.

4. Supports: Provide the following top and bottom supports:
   a. Top: 1-1/4" Schedule 40 pipe
   b. Bottom: Tension wire

2.3 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:

1. Fence Height: As indicated on Drawings.

2. Heavy Industrial Strength (Minimum steel yield strength 80,000 psi): Material Group IA, round steel pipe, Schedule 40.

   a. Line Post: 2.0 inches in diameter.
   b. End, Corner and Pull Post: 2.5 inches in diameter.

3. Horizontal Framework Members: Top rail complying with ASTM F 1043.
4. Brace Rails: Comply with ASTM F 1043.
5. Metallic Coating for Steel Framing:

   a. Zinc coating 1.8 oz/ft^2 on the inside and outside surface.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: 7-gauge, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:

1. Type II, zinc coated with minimum coating weight matching chain-link fabric coating weight.

2.5 FITTINGS

A. General: Comply with ASTM F 626.

B. Post caps:
1. Provide post caps that fit snugly over posts to exclude moisture.
   a. Provide dome style caps for terminal posts.
   b. When top rail is specified provide line post loops to secure top rail.

C. Barbed Wire Arms: Galvanized pressed steel, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts, integral with post cap; for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.

D. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. zinc ASTM F 626.

2.6 FABRIC ACCESSORIES

A. Wire Clips: Minimum 6 gauge hot dip galvanized

B. Tension Bars: ¼ inch by ¾ inch, galvanized

C. Truss Rod Assembly: Galvanized steel minimum 3/8" diameter with pressed steel tightener (galvanized).

D. Steel Bands: 11 gauge, 1 inch wide, hot dip galvanized.

E. Bolts and Nuts: 3/8 inch diameter, galvanized and of commercial quality

2.7 BARBED WIRE

A. Fence:
1. Number of Strands: 3
2. Wires per strand: 2
3. 12.5 gauge galvanized wires with 14 gauge, 4 point galvanized barbs (at no more than 5 inches on center spacing).
4. Coatings: Galvanize in accordance with ASTM A 121, Class 2.

2.8 CHAIN LINK GATES

A. Frames and center supports: minimum 1-7/8-inch outside diameter.

B. Gate accessories:
1. Post top fittings:
   a. Provide post caps that fit snugly over posts to exclude moisture.
   b. Provide dome style caps for terminal posts and loop style caps for line posts.
   c. Post top fittings: Extension arms, 45-degree angle type, capable of receiving three strands of barbed wire.
2. Corner fittings: Heavy pressed steel or malleable castings.
3. Gate tensioning:
   a. Cross tensioning rods: 3/8 inch, galvanized.
   b. Turnbuckles: Heavy duty.
4. Tension rods for 4-foot gates: 3/8 inch, easily adjustable, galvanized.
5. Gate frame corner fittings: Fittings designed for purpose, manufacturer's standard.

6. Horizontal gate stiffeners: 1-5/8 – inch outside diameter galvanized steel pipe in accordance with ASTM F1043, group IA.
7. Gate hardware:
    a. Catch and locking attachment: combination steel or malleable iron catch and locking attachment of acceptable design.
    b. Stops:
        1) Capable of holding gates open.
    c. Color: Match color of fabric.

2.9 ALUMINUM SLIDE GATE

A. Gate Frame: ASTM F 1183 Type II Class 2 Gate to be made of Aluminum Alloy 6063-T6. All square upright members are 2" sq. weighing 0.94 lb/ft ASTM B221. Complete frame welded to top and bottom frame member 4" x 2" rail.

B. Interior Horizontal Rails: 1-5/8” mounted to posts with galvanized track brackets.

C. Gate post brackets, latch and keepers are galvanized steel.

D. Bracket and roller assemble 2-1/2” X 6” rubber rollers.

E. Gate posts are 4" OD minimum.

F. Latching/locking system to allow for closure of two adjacent gates.

2.10 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

D. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

E. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

F. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
    b. Concealed Concrete: Top 2 inches below grade as indicated on Drawings to allow covering with surface material.

G. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment and as indicated on Drawings. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

H. Line Posts: Space line posts uniformly at 10 feet o.c.

I. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Provide horizontal tension wire at the following locations:

1. Extended along top and bottom of fence fabric.
2. As indicated.

J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch between finish grade of surface and bottom selvage unless otherwise indicated.

K. Barbed Wire: Install barbed wire uniformly spaced as indicated on Drawings. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

L. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

M. Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

N. Cantilever slide gates: Install cantilever horizontal slide gates and gate posts in accordance with ASTM F567. Cantilever sliding gates shall be plumb in the closed position with minimal ground clearance and slide with an initial force of 40 lbs.

3.2 SITE CLEAN UP

A. Clean up area adjacent to fence line from debris and unused material created by fence installation

END OF SECTION 323113

SECTION 330505 – PIPELINE TESTING

PART 1 - GENERAL

1.1. SUMMARY

A. The Contractor shall perform flushing and testing of all pipelines and appurtenant piping complete, including conveyance of test water from Owner-designated source to point of use and all disposal thereof, all in accordance with the requirements of the Contract Documents.

B. Section includes provisions for following piping testing:

a. Testing of alignment, grade, and deflection;
b. Gravity flow piping testing;
c. Hydrostatic High Head pressure testing;
d. Hydrostatic Low Head pressure testing;
e. Low pressure air testing;
f. High pressure air testing.

1.2. RELATED SECTIONS

A. General Pipes and Fittings. Section 220050

B. Ductile Iron Pipe. Section 400519

C. Plastic Pipe. Section 400531

D. High Density Polyethylene Pipe and Fittings. Section 400533

E. Stainless Steel Piping and Tubing. Section 400523

F. Steel Piping and Fabricated Steel piping. Section 400524

G. Water Piping. Section 221116

H. Sanitary Waste and Vent Piping. Section 221316

I. Hydraulic Structure Testing. Section 331400

1.3. SUBMITTALS

A. Schedule and Notification of tests:

a. Submit a list of scheduled piping tests by noon of working day preceding the date of scheduled tests.
b. Notification of readiness to test: Before testing notify the Engineer or Construction Manager in writing of readiness to test piping.

c. Have personnel, materials, and equipment required for testing in place before submitting notification of readiness.

B. Provide a test report for each piping system tested. Include the following:

a. Date of Test;
b. Description and identification of piping system tested;
c. Results of alignment, grade, and deflection testing;
d. Type of test performed;
e. Test fluid;
f. Test pressure;
g. Type and location of leaks detected;
h. Corrective action taken to repair leaks;
i. Results of re-testing.

C. Submit test report in accordance with Specification Section 13300.

1.4. SEQUENCE

A. Test Piping Systems as follows:

a. Clean piping before pressure or leak tests.
b. Test exposed, non-insulated piping systems upon completion of system (including supports, hangers, anchors, etc.)
c. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
d. Test concealed interior piping systems prior to concealment and, if system is insulated prior to application of insulation.
e. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.
f. Test buried piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 - PRODUCTS

2.1. MATERIALS REQUIREMENTS

A. All test equipment, temporary valves, bulkheads or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review.

PART 3 - EXECUTION

3.1. GENERAL

A. Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use.

B. All pipelines shall be tested. All testing operations shall be performed in the presence of the Construction Manager.

C. Provide air supply.

D. Plug pipe outlets with test plugs. Brace each plug securely to prevent blowouts.

E. Add test fluid slowly.

F. Include regulator set to avoid over-pressurizing and damaging piping.

G. Perform pressure testing in accordance with local, state, and federal requirements.

H. Correct leaks or defects at no additional cost to Owner and as approved by the Engineer.

I. Disposal or release of test water from pipelines after testing, shall be acceptable to the Engineer.

3.2. TESTING ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and grade:

a. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
b. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection test:

a. Pull a mandrel through the clean piping section under test.
b. Perform the test no sooner than 30 days after installation and not later than 60 days after installation or permanent surfacing.
c. Use a full circle, solid cylinder, or a rigid non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder mandrel approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

3.3. TESTING OF GRAVITY FLOW PIPING

A. Test gravity flow piping indicated with “G” in piping schedule, as follows:

a. Unless specified otherwise, subject gravity flow piping to the following tests:

i. Alignment and grade.
ii. For plastic piping test for deflection.

iii. Visible leaks and pressure with maximum leakage allowance.

b. Inspect piping for visible leaks before backfilling.
c. Provide temporary restraints when needed to prevent movement of piping.
d. Pressure test piping with maximum leakage allowance after backfilling.
e. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under the head indicated in the piping schedule for the water at least 24 hours:

i. Examine piping for visible leaks. Correct any visible leaks. Consider examination complete when no visible leaks are observed.
ii. Maintain piping with water, or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
iii. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of 4 hours while accurately measuring the volume of water added to maintain the test pressure:

1. Consider the test completed when leakage is equal or less than the following maximum leakage allowance:

a) For concrete piping with rubber gasket joints: 80 gallons per day per inch of diameter per mile of piping under test.
b) For HDPE Strom Drain Piping use manufacturer recommended leakage rates.
c) Test sanitary waste and vent piping in accordance with section 221316 requirements.
d) For other piping: 80 gallons per day per inch diameter per mile of piping under test.

B. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

C. Test waste, drain and vent systems in accordance with local plumbing code and these specifications. Repair failed sections by disassembly and reinstallation.

3.4. HYDROSTATIC HIGH HEAD TESTING OF PIPELINES

A. Test piping indicated “HH” in the Piping Schedule with the high head pressure test method.

B. General:

a. The test pressure for yard piping shall be as shown or specified on the Piping Schedule measured at the lowest point of the pipeline section being tested. Where not indicated in the Piping Schedule, test piping systems at 150% of the operating pressure indicated, but not less than 25 psi. Observe each test section for leakage at the end of the test period. Test fails if leakage is observed or if there is any pressure drop in the system. All leaks shall be repaired in a manner acceptable to the Engineer.
b. Prior to hydrostatic testing, all pipelines shall be flushed or blown out as appropriate. The Contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained

to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Care shall be taken to see that all air vents are open during filling. Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed, and remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.

C. Testing Procedures:

a. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled it shall be allowed to stand under a slight pressure for at least 24-hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.

b. Use potable water for all potable water lines testing.

c. Test piping for minimum 2 hours for visible leaks and minimum 2 hours for the pressure test with maximum leakage allowance.

d. Raise pressure to the specified test pressure and inspect piping visually for leaks:

i. Correct any visible leaks,

ii. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:

a. Leakage allowance is zero for all exposed (insulated or non-insulated) piping and all piping systems using flanged, National Pipe Thread threaded and welded joints.

b. Pressure test piping after completion of visible leaks test.

c. Buried piping with mechanical joints or push-on joints, piping systems shall have maximum allowable leakage of

$$L = (NxDxP^{(1/2)})/7,400$$

Where:
L = Leakage, gallons per hour
N = Number of joints under test
D = Nominal diameter of piping, inches
P = Average pressure during test, pounds per square inch
x = multiplication symbol.

E. Pressure test HDPE pipe in accordance with the requirements of section 221050 “High Density Polyethylene Pipe and Fittings”.

F. Pressure test potable water piping in accordance with the requirements of section 221116 “Water Piping”.

G. Pressure test PEX piping systems in accordance with the requirements of section 238316.

H. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

I. Drain and dispose of test water from piping systems as directed by the Construction Manager or Engineer after testing and repair work has been completed.

J. Test all pressure piping in accordance with ANSI B31.

3.5. HYDROSTATIC LOW HEAD TESTING OF PIPELINES

A. Test piping indicated "LH" in the Piping Schedule with the low head pressure test method.

B. General:

a. Test pressures shall be as noted in the pipe schedule.
b. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
c. Test connections, blowoffs, vents closure pieces, and joints into structures including existing bell rings and other appurtances with the piping.
d. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Visible Leaks Test:

a. Subject piping under test to the specified pressure measured at the lowest end.
b. Fill piping under test slowly with water while venting air:
    i. Use potable water for all potable waterlines.
c. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
d. Raise pressure to the specified test pressure and inspect piping visually for leaks. Correct any visible leaks. Consider testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance.

a. Pressure test piping after completion of visible leaks test.
b. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
    i. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test and no damage to piping and appurtances has occurred.
    ii. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtances has occurred.

3.6. LOW PRESSURE AIR TESTING

A. Perform low pressure air testing for gravity sewer and drainage piping systems where indicated "AL" in the Piping Schedule.

B. Test pipes between adjacent manholes. Test time for air pressure to drop 1.0 psi.

a. For pipes 4 in. through 36 in. diameter to comply with Table 1.

b. Pipe over 36 inch diameter shall not be tested by the low pressure air method.

C. Preparation:

a. Isolate pipe section to be tested by plugging each end with air tight plugs. Plug end of branches, laterals and wyes which are not to be included in the test section.
b. Brace plugs to prevent slippage and blowout due to internal pressure.
c. One plug shall have inlet tap or other provision for connecting air supply.
d. Air control equipment shall consist of valves and pressure gauges to control rate at which air flows into test section and gauges to monitor air pressure inside pipe.

D. Testing:

a. If pipe to be tested is submerged in water, determine height of water above spring line of pipe at each end of test section and compute average. For each foot of water above pipe's spring line, increase test pressure by 0.43 psi.
b. Add air slowly until pressure inside pipe is raised to 5.0 psi. greater than average back pressure of water that may be over pipe.
c. After pressure of 5.0 psi is obtained, control supply of air so the internal pressure is maintained between 4.5 and 5.0 psi (above average water back pressure) for minimum of 2 minutes to allow temperature of air to come into equilibrium with temperature of pipe.
d. In no case shall the test pressure exceed 9.0 psi or the maximum pressure allowed by the pipe manufacturer.
e. Determine the rate of air lost by time pressure drop method.
    i. After temperature stabilized for a 2 minute period, disconnect air supply. Allow pressure to decrease to 4.6 psi. At this pressure, start stopwatch to determine time required for pressure to drop 1.0 psi. Time required for loss of 1.0 psi is then compared to Table 1.
    ii. If time is equal to or greater than time indicate din table, test shall be acceptable.
    iii. If time is less than time indicated in table, make appropriate repairs and retest.

Table 1. Low Pressure Air Test Times for 1.0 PSIg Pressure Drop.

Pipe Diameter (in)	Minimum Time for 1.0 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length (L) in Excess of Minimum (sec.)
4	03:47	597	.380L
6	05:40	398	.854L
8	07:33	298	1.520L
10	09:27	239	2.374L
12	11:20	199	3.418L
15	14:10	159	5.342L
18	17:00	133	7.692L
21	19:50	114	10.470L
24	22:40	99	13.674L
27	25:30	88	17.306L
30	28:20	80	21.366L
33	31:10	72	25.852L
36	34:00	66	30.768L

E. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

3.7. HIGH PRESSURE AIR TESTING

A. Perform high pressure air testing for gravity sewer and drainage piping systems where indicated "AH" in the Piping Schedule.

B. Perform preliminary test at not greater than 25 psi. Examine for leakage at joints with soap solution and visual detection of soap bubbles. Correct visible leaks.

C. Perform final test at the pressure specified. Pressure in the system shall be gradually increased until the test pressure is reached. Test pressure shall be maintained for a minimum of 10 minutes and additional time conduct soap bubble test examination of each joint for leakage.

D. Piping system shall show no evidence of leakage. If leakage is evident, make appropriate repairs and retest.

END OF SECTION 330505

SECTION 331400 – HYDRAULIC STRUCTURES TESTING

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all cleaning, flushing, testing and appurtenant work, including conveyance of test water from Owner-designated source to point of use, and including all disposal thereof, complete and acceptable, for hydraulic structures and appurtenant piping all in accordance with the requirements of the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Pipeline Testing. Section 330505

B. Cast-In-Place Concrete. Section 033000

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. Temporary valves, bulkheads or other water control equipment and materials shall be as determined by the Contractor subject to the Engineer's review.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to testing, all hydraulic structures shall be thoroughly cleaned and all surfaces hosed down with a high pressure hose and nozzle. All water, dirt and foreign material accumulated in this cleaning operation shall be removed from the structure.

B. The Contractor shall conduct leakage testing of concrete structures subject to hydrostatic pressure and all appurtenant piping. All testing operations shall be done in the presence of the Engineer.

C. The Contractor shall notify the Engineer at least 48-hours in advance of any planned testing and shall review with the Engineer the testing procedures.

D. Water from the Owner’s reclaimed water system will be provided for testing. However, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use.

E. If industrial paint finishes or other protective coatings are to be applied to the interior surfaces of the hydraulic structure, such coatings shall be applied after all testing operations have been completed.

F. Disposal of test water from structures, after testing has been completed, shall be acceptable to the Engineer.

3.2 TESTING OF HYDRAULIC STRUCTURES

A. General: Testing shall be performed prior to backfilling, except where otherwise acceptable to the Engineer (See drawings for additional requirements). Testing shall not be performed sooner than 14-days after all portions of structure walls and associated roof systems have been completed. The test shall consist of filling the structure with water to the maximum operating water surface. The rate of filling shall not exceed 48-inches of depth per day.

B. Evaporation Calculations: To accurately measure the amount of evaporation, the following procedure shall be observed:

1. A standard 5 gallon bucket shall be filled just below the top, and the elevation noted. The bucket shall then be placed in the water of the structure being tested once filling of the structure is complete.
2. Upon completion of the hydraulic testing of the structure, the amount of water evaporated from the bucket shall be taken as the evaporation amount in the structure.

C. Leakage Test and Repairs: After the structure has been filled, the leakage test shall be performed as follows: An initial water level reading shall be made. Seven days following the initial reading, a second reading shall be made. The structure shall be considered to have passed the test if water loss during the 7-day period, as computed from the two water level readings, does not exceed 0.2 percent of the total volume of water in the structure, after allowance is made for evaporation loss. If intermediate readings or observed leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before commencing a new 7-day test period. If the structure continues to fail the leakage test, the Contractor shall empty the structure and shall examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage. Any cracks shall be "vee'd" and sealed with polyurethane sealant in accordance with Section 033000 entitled, "Cast-In-Place Concrete". Any evidence of leakage shall be repaired. Following these operations, the Contractor shall again test the hydraulic structure. The structure will not be accepted as completed until it has passed the leakage test.

3.3 TESTING OF APPURTENANT PIPING

A. Piping appurtenant to hydraulic structures shall be tested as specified in Section 330505 entitled, "Pipeline Testing".

END OF SECTION 331400

SECTION 334200 – FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals necessary and install and test reinforced concrete pipe for storm drains complete as shown on the Drawings and as specified herein.

B. All pipe and fittings shall be manufactured for this project and no pipe shall be furnished from stock.

1.2 RELATED WORK

A. Installation and testing of plumbing is included in Division 33.

B. Earthwork is included in Division 31.

1.3 SUBMITTALS

A. Submit, in accordance with Section 013300 Contractor Submittals, shop drawings showing layout and details of reinforcement, joint, method of manufacture and installation of pipe, gasket, specials and fittings, the name of the pipe manufacturer and a schedule of pipe lengths including the length of individual pipes by diameter for the entire job.

B. Submit with the shop drawings documentation that the fine and course aggregates to be used in manufacture of the concrete pipe comply with the requirements of Paragraph 2.01C. Documentation shall be less than 6 months old and shall indicate the source of the aggregates and the date of the analysis.

C. Prior to each shipment of pipe, submit certified test reports that the pipe was manufactured and tested in accordance with the ASTM Standards specified herein.

D. Submit the results of the compressive strength tests to the Engineer.

1.4 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 - Standard Specification for Concrete Aggregates.

2. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.

3. ASTM C150 - Standard Specification for Portland Cement.

4. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.

5. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

6. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections or Tile.

7. ASTM 969 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE

A. The manufacturer shall perform the acceptance tests in accordance with ASTM C76.

B. Reinforced concrete pipe manufactured for this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory provided by the Owner. The manufacturer's cooperation in these inspections shall be required.

C. Inspection of the pipe will be made by the Engineer or other representatives of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

PART 2 PRODUCTS

2.1 REINFORCED CONCRETE PIPE

A. Except as otherwise specified herein, pipe shall conform to ASTM C76, Class V. The pipe interior shall be smooth and even, free from roughness, projections, indentations, offsets, or irregularities of any kind. The concrete mass shall be dense and uniform.

B. Cement shall be non-air-entraining Portland Cement conforming to ASTM C150, Type II. The use of any admixture shall be subject to the specific approval of the Engineer.

C. Fine aggregate shall consist of washed inert sand conforming to the requirements of ASTM C33, except for gradation, with a maximum loss of 8 percent when subjected to 5 cycles of the soundness test using magnesium sulfate. Coarse aggregate shall consist of well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33, except for gradation, with a maximum loss of 8 percent when subjected to 5 cycles of the soundness test using magnesium sulfate. Documentation that the aggregates to be used in the manufacture of reinforced concrete pipe meet these requirements shall be submitted to the Engineer as stated in Paragraph 1.03 above.

D. The 28-day compressive strength of the concrete as indicated by cores cut from the pipe or from representative test cylinders taken from the same batch shall be equal to or greater than the design strength of the concrete. The concrete mass shall be dense and uniform.

The average adsorption shall not exceed the percentages specified in ASTM C76, Section 11.9. Quadrant steel shall not be used. Reinforcement shall be installed in both the bell and the spigot. At least one circumferential reinforcement wire shall be in both the bell and spigot area and reinforcement in the bell and spigot shall be adequate to prevent damage to concrete during shipping, handling and after installation. The pipe shall be subjected to a 3-edge bearing test and hydrostatic testing to 13 psi for 10 minutes in accordance with ASTM C443 to verify strength and water tightness. Both the 3-edge bearing test in accordance with ASTM C497 and the hydrostatic test shall be performed at the rate of one pipe per 800 hundred feet of pipe manufactured. The Owner reserves the right to witness the testing.

E. Pipe may be rejected for any of the following reasons:

1. Exposure of any wires, positioning spacers or chairs used to hold the reinforcement in place, or steel reinforcement in any surface of the pipe, except for the ends of the longitudinal, stirrups or spacers specifically permitted by Section 8.2 of ASTM C76.

2. If cores taken show that the transverse reinforcing steel is found to be in excess of 1/4-in out of specified position after the pipe is molded.

3. Any shattering or flaking of concrete at a crack.

4. Voids, with the exception of minor bug holes, on the interior and exterior surfaces of the pipe exceeding 1/4-in in depth unless properly and soundly pointed with mortar or other approved material.

5. Unauthorized application of any wash coat of cement or grout. Any pipe dressing procedures shall be subject to approval of the Engineer.

6. A deficiency greater than 1/4-in from the specified wall thickness of pipe 30-in or smaller in internal diameter.

7. A hollow spot identified by tapping the internal surface of the pipe which is greater than 30-in in length or wider than 3 times the specified wall thickness. Repair of such defective areas not exceeding these limitations may be made as specified in Paragraph 2.01M.

8. Defects that indicate imperfect molding of concrete; or any surface defect indicating honeycomb or open texture rock pockets greater in size than area equal to a square with a side dimension of 2-1/2 times the wall thickness or deeper than two times the maximum graded aggregate size; or local deficiency of cement resulting in loosely bonded concrete, the area of which is greater than 30-in in length or wider than 3 times the specified wall thickness when the defective concrete is removed. Repair of such defects not exceeding these limits may be made as specified in Paragraph 2.01M.

9. Any of the following:

    a. A crack having a width of 0.005 to 0.01-in throughout a continuous length of 36-in or more.

    b. A crack having a width of 0.0 to 0.03-in or more throughout a continuous length of 1-ft or more.

c. Any crack greater than 0.005-in extending through the wall of the pipe and having a length in excess of the wall thickness.

d. Any crack showing two visible lines of separation for a continuous length of 2-ft or more, or an interrupted length of 3-ft or more anywhere in evidence, both inside and outside.

e. Cracks anywhere greater than 0.03-in in width.

F. The pipe shall be clearly marked as required by ASTM C76 in a manner acceptable to the Engineer. The markings may be at either end of the pipe for the convenience of the manufacturer, but for any one size shall always be at the same end of each pipe length. Pipe shall not be shipped until the compressive strength of the concrete has attained as percent of the design strength and not before 7 days after manufacture and/or repair, whichever is the longer.

G. Pipe shall have a minimum laying length of approximately 8-ft, except for closure and other special pieces as approved by the Engineer. Have available at the site sufficient pipe of various lengths to affect closure at manholes or structures that cannot be located to accommodate standard lengths. Short lengths of pipe made for closure, etc, may be used in the pipeline at the end of construction if properly spaced. The length of the incoming and outgoing concrete pipe at each structure shall not exceed 4-ft, except where the joint is cast flush with the exterior wall of the structure or where otherwise noted on the Drawings. Maximum laying length shall not exceed 16-ft, but the installation of 16-ft lengths will depend upon the ability to handle such lengths of pipe in sheeted trenches, comply with trench width requirements, maintain the integrity of the sheeting and avoid disturbance to adjacent ground. If in the opinion of the Engineer the use of 16-ft lengths is impractical, shorter lengths shall be used.

H. Each length of pipe shall be checked against the length noted on the shop drawings. Pipe more than 1-1/2-in longer than that shown on the shop drawings shall not be used on this project. Variations in length of the same pipe shall not exceed ASTM C76 requirements.

I. The Engineer shall have the right to cut cores from such pieces of the finished pipe as he/she selects for inspection and for such tests as he/she may wish to apply. Holes left by the removal of cores shall be filled in an approved manner by and at the expense of the manufacturer. Core drilling shall be carried out by the pipe manufacturer at his/her expense. The number of cores shall not exceed the requirements of ASTM C76.

J. The pipe will be carefully examined for compliance with the appropriate ASTM standard, as specified herein, and shop drawings by the manufacturer prior to shipment. All pipes shall be inspected for general appearance, dimension, "scratch-strength," blisters, cracks, roughness, soundness, etc. All pipes will be checked for soundness by being tapped and scratched at least once on every 50 sq inch of pipe surface. The surface shall be dense and close-textured. Cores also shall serve as a basis for rejection of pipe, particularly if lamination or poor bond of reinforcement is apparent.

K. The manufacturer shall use measuring devices to assure joint assembly is within tolerances of ASTM C76 and as specified herein. If, during construction, the pipes cannot be satisfactorily joined, the manufacturer shall pre-join the pipe at the plant.

L. Only pipe actually conforming to the requirements of ASTM C76 and these specifications shall be shipped. Approved pipe will be so stamped or stenciled on the inside before it is shipped. All pipe which has been damaged after delivery will be rejected and if such pipe already has been laid in the trench, it shall be removed and replaced, entirely at the Contractor's expense.

M. Pits, blisters, rough spots and other imperfections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Non-shrink cement mortar used for repairs shall have a minimum compressive strength of 6,000 psi at the end of 7 days and 7,000 psi at the end of 28 days, when tested in 3-in cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Engineer.

2.2 JOINTS FOR CONCRETE PIPE

A. Joints shall be bell and spigot type joint conforming to ASTM C361 or C443 with provisions for using a round rubber O-Ring gasket in a recess in the spigot end of the pipe or profile gasket in a single step joint. B. The gaskets shall conform to ASTM C361 or ASTM C443 except as otherwise specified herein.

B. The joint and gaskets shall be designed and manufactured so that the completed joint will withstand an internal water pressure in excess of 13 psi for a period of 10 minutes without showing any leakage by the gasket or displacement of it. The pipe manufacturer shall provide facilities for testing the effectiveness of the joints against leakage and one such test may be required for each 800-ft of pipe for each type of joint manufactured. Such tests shall be made by an internal or external pressure against the joint of at least 13 psi for a period of ten minutes in accordance with ASTM C443. The completed joint, when installed in place in the work, shall be capable of withstanding a groundwater pressure of 13 psi without exceeding the allowable leakage specified for the pipe testing.

C. The pipe manufacturer shall furnish information and be on hand during the installation of the first five joints installed under this Contract.

D. The ends of the pipe shall be made true to form and dimension and the bell shall be made by casting against steel forms. The manufacturer shall inspect all pipe joint surfaces for out-of-roundness and pipe ends for squareness.

PART 3 EXECUTION

3.1 LAYING CONCRETE PIPE

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or fittings and the joint surfaces. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective.

B. As soon as the excavation is completed to the normal grade of the bottom of the trench, place screened gravel bedding in the trench and firmly bed the pipe in this gravel to conform accurately to the lines and grades indicated on the Drawings. Blocking under the pipe will not be permitted.

C. Prior to the installation of any pipe, review the proposed method of installation with the Engineer. Jacks or come-alongs shall be used to force the pipes home. The use of other methods, including

the use of motor driven equipment, shall be reviewed by the Engineer. The Engineer reserves the right to direct the Contractor to revise his operation at any time within this Contract.

D. A depression shall be left in the supporting gravel at the joint to prevent contamination of the rubber gasket. Before the pipe is lowered into the trench, the spigot and bell shall be cleaned and free from dirt. Gasket and bell shall be lubricated by a vegetable lubricant which is not soluble in water, furnished by the pipe manufacturer and harmless to the rubber gasket. The pipe shall be properly aligned in the trench to avoid any possibility of contact with the side of the trench and fouling the gasket. As soon as the spigot is centered in the bell of the previously laid pipe, it shall be engaged by approved methods.

E. After the gasket is compressed, but before the pipe is brought home, each gasket shall be checked for proper position around the full circumference of the joint. Steel inserts shall be used to prevent the pipe from going home until the feeler gauge is used to check the final position of the gasket.

F. As soon as the pipe is in place and before the come-along is released, backfill shall be placed as indicated on the Drawings and compacted for at least one-half the length of pipe. Not until this backfill is placed shall the come-along be released. If any motion at joints can be detected, a greater amount of backfill shall be placed before pressure is released. When pipe laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by a watertight plug or other approved means.

G. For each of the pieces to be supplied and used for saddles, plug the remaining two holes not used for the service with non-shrink cement mortar.

H. Regulate the equipment and construction operations such that the loading of the pipe does not exceed the loads for which the pipe is designed and manufactured. Any pipe damaged during construction operations shall promptly and satisfactorily be repaired or replaced at the Contractor's expense.

END OF SECTION 334200

SECTION 334510 - FIRE HYDRANTS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide fire hydrants, complete and operable, including all appurtenances and accessories, in accordance with the Contract Documents.

PART 2 - RODUCTS

2.1 DRY-BARREL FIRE HYDRANTS

A. Construction: Unless otherwise shown, all hydrants shall be of the dry-barrel type according to ANSI/AWWA C 502, with one 4-1/2-inch national standard thread pumper nozzle and two 2-1/2-inch national standard thread hose nozzles, and a 6-inch diameter inlet. All nozzles shall be provided with cast iron caps with gasket and metal attaching chains. The barrel shall have a cast iron break-away section above ground and a lower barrel of ductile iron, with an elbow or tee-section at the base. The stem shall have a break-away coupling, or there shall be some other safety device in case of a fracture.
The drip valve shall be located near the bottom of the hydrant. It shall be positive in operation and shall work directly from the main stem. It must be so designed that all water will drain away from the working parts when the hydrant is closed. Provisions must be made for oiling, both for lubrication and to prevent corrosion. A reasonably tight fit should be made around the stem. On the cover an arrow and the word “OPEN” shall be placed in raised characters to indicate direction to turn to open the hydrant. The hydrant must be marked with the name or particular mark of the manufacturer. The size of the hydrant shall also be cast in the barrel. All lettering shall be above the ground or sidewalk flange.

B. Each hydrant shall be isolated by an individual, buried 6-inch flange by mechanical joint gate valve, with armor guard gasket. All buried valves shall have 2” operating nust and cast iron valve box and cover. All bolts, nuts, and washers shall be of Type 316 stainless steel, except where otherwise required for structural reasons. The hydrants shall be tested to 300 psig and they shall be suitable for a working pressure of 150 psig. All interior and exterior surfaces shall be coated in accordance with AWWA C 550.

2.2 MANUFACTURERS, OR EQUAL:

A. Mueller-Super Centurion 200

B. American Flow Control-Waterous Pacer

PART 3 - EXECUTION

3.1 INSTALLATION

A. All fire hydrants shall be installed in strict accordance with the manufacturer's published recommendations, AWWA Standards, and all applicable codes, and the applicable provisions of Section 40 05 51 - Valves, General. All installations shall be to the satisfaction of the local fire and building department.

B. All hydrants shall be installed with a 1 cubic yard gravel sump and concrete thrust block, calculated for the maximum expected water pressure. Provide geotextile material around drain rock and overlap a minimum of 18-inches.

C. Place fire hydrants so that sidewalk flange is at least 2-inches above finished grade, but no more than 6-inches above finished grade.

D. The 4-1/2-inch steamer nozzle shall be directed to the street side of the fire hydrant.

E. Apply poly-fm grease to all buried metal surfaces and wrap with 8 mil thick polyethylene sheet and tape wrap prior to pouring concrete thrust blocks.

END OF SECTION 334510

SECTION 335100 - NATURAL-GAS DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section specifies materials and procedures for the construction of outside underground gas distribution system for natural gas, complete, ready for operation, all appurtenant structures, and connections to existing building structures and to existing gas supply. This specification does not apply to LPG distribution systems.

1.2 RELATED WORK

A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Document 312000, Earth Moving.

B. Submittals: Document 013300, Shop Drawings, Product Data and Samples.

C. Exterior Pipe Coatings: Document 098000, Protective Coatings

D. Metering: Document 409123, Miscellaneous Process Measurement Devices.

1.3 DEFINITIONS

A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 ABBREVIATIONS

A. MDPE: Medium-density polyethylene plastic

B. HDPE: High-density polyethylene plastic

C. PE: Polyethylene plastic

D. NRTL: National recognized testing laboratory

1.5 DELIVERY, STORAGE, AND HANDLING

A. Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.6 COORDINATION

A. Coordinate connection to natural-gas main with Utility Company and Owner. See Section 3.9 of this document.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate exterior utility lines and connections to building services up to the actual extent of building wall.

1.7 QUALITY ASSURANCE:

A. Products Criteria:

1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

B. Comply with the rules and regulations of the Utility Company having jurisdiction over the connection to public natural-gas lines and the extension, and/or modifications to public utility systems.

1.8 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred in the text by basic designation only.

B. American National Standards Institute (ANSI):
B31.8-2010 .....Gas Transmission and Distribution Piping Systems
Z21.80a-2005/CSA 6.22a .....Line Pressure Regulators, Addenda 1 to Z21.80-2003/CSA 6.22

C. American Petroleum Institute (API):
Spec 6D-2010 .....Pipeline Valves

D. American Society of Civil Engineers (ASCE):

25-06	Earthquake Actuated Automatic Gas Shutoff Devices

E. American Society of Mechanical Engineers (ASME):

B1.20.1-1983	Pipe Threads, General Purpose, Inch
B16.5-2009	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
B16.9-2007	Factory-Made Wrought Buttwelding Fittings
B16.11-2009	Forged Fittings, Socket-Welding and Threaded
B16.33-2002	Manually Operated Metallic Gas Valves for use in Gas Piping Systems up to 125 psi (Sizes NPS 1/2 through NPS 2)
B16.34-2009	Valves - Flanged, Threaded and Welded End
B16.38-2007	Large Metallic Valves for Gas Distribution Manually Operated, NPS 2-1/2 (DN 65) to NPS 12 (DN 300), 125 psig (8.6 bar) Maximum
B16.40-2008	Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems
B18.2.1-2010	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
B31.8-2010	Gas Transmission and Distribution Piping Systems

F. American Society for Testing and Materials (ASTM):

A53/A53M-10	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A312/A312M-11	Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
D2513-11e1	Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
D2683-10	Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
D2774-08	Underground Installation of Thermoplastic Pressure Piping
D3261-10a	Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

G. American Welding Society (AWS):

A5.8/A5.8M:2004	Filler Metals for Brazing and Braze Welding
D10.12/D10.12M:2000	Guide for Welding Mild Steel Pipe

H. Manufacturers Standardization Society (MSS):

SP-78-2005	Gray Iron Plug Valves Flanged and Threaded Ends
SP-110-2010	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

I. National Fire Protection Agency (NFPA):

54-2009	National Fuel Gas Code

1.9 WARRANTY

A. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting there from within a period of two years from final acceptance. Further, the Contractor will furnish all manufacturer's and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: Steel pipe, above ground, shall be as per ASTM A53, black steel, Schedule 40, Type E, Grade B.

B. Fittings:

1. Butt weld fittings shall be wrought steel, per ASME B16.9.
2. Wrought-Steel Welding Fittings shall meet ASTM A234 for butt welding and socket welding.
3. Forged-Steel Flanges and Flanged Fittings shall be ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    a. End Connections shall be threaded or butt welded to match pipe.
    b. Lapped Face is not permitted underground.
    c. Gasket Materials shall be ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    d. Bolts and Nuts shall be ASME B18.2.1, carbon steel aboveground and stainless steel underground.

4. Mechanical Couplings shall include:
    a. Steel flanges and tube with epoxy finish.
    b. Buna-nitrile seals.
    c. Stainless-steel bolts, washers, and nuts.
    d. Couplings shall be capable of joining steel pipe to steel pipe.

C. PE Pipe: Pipe shall conform to ASTM D2513.
1. Materials used for the manufacture of polyethylene pipe and fittings shall be PE 2406 SDR 11, medium density polyethylene meeting cell classification 234363E per ASTM D 3350 and shall be listed in PPI (plastics pipe institute) TR-4 with standard grade HDB ratings of 1250 psi and 73 degrees F, and 1000 psi at 140 degrees F. All pipe and fittings materials shall be opaque yellow in color. Materials shall be stabilized against ultraviolet deterioration and shall be suitable for unprotected outdoor storage for at least four (4) years.
2. The same manufacturer shall supply polyethylene pipe and heat fusing fittings.
3. Pipe and fittings shall be manufactured and tested in accordance with the latest published edition of ASTM D 2513 (for socket-fusion type) or ASTM D 3261 for butt-fusion type fittings. Fusion fittings shall be manufactured in accordance with ASTM D 2513 and D.O.T. requirements.
4. The pipe and fittings manufacturer shall have an established quality control program

responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, UV protection and contamination. The supplier shall certify the cell classification properties of incoming material.

5. All product shall be verified for diameter, wall thickness, roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut. Quality control shall verify production checks, and test for density, melt flow rate, hoop tensile strength and ductility. Manufacturer shall maintain records of manufacturing location, pipe production and resin lots for at least 50 years.
6. The manufacturer shall certify the inspection and testing of materials and products.
7. PE Transition Fittings shall be factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53, black steel, Schedule 40, Type E or S, Grade B.
8. Anode-less Service-Line Risers shall be factory fabricated and leak tested.
    a. Underground portion shall be PE pipe complying with ASTM D2513.
    b. Casing shall be steel pipe complying with ASTM A53, Schedule 40, black steel, Type E, Grade B, with corrosion-protective coating covering.
    c. Aboveground portion shall have PE transition fittings. Outlet shall be threaded or suitable for welded connection. Include tracer wire connection and ultraviolet shield.
    d. Stake supports with factory finish to match steel pipe casing or carrier pipe.

9. Transition Service-Line Risers shall be factory fabricated and leak tested.
    a. Underground Portion shall be PE pipe complying with ASTM D2513, connected to steel pipe complying with ASTM A53, Schedule 40, Type E, Grade B, with corrosion-protective coating for aboveground outlet.
    b. Outlet shall be threaded or flanged or suitable for welded connection. Include factory-connected anode, tracer wire connection and ultraviolet shield.
    c. Stake supports with factory finish to match steel pipe casing or carrier pipe. Bridging sleeve over mechanical coupling.

10. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
    a. PE body with molded-in, stainless steel support ring.
    b. Buna-nitrile seals.
    c. Acetal collets.
    d. Electro-zinc-plated steel stiffener.

11. Plastic Mechanical Couplings, NPS 2 and Larger shall be Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
    a. Fiber-reinforced plastic body.
    b. PE body tube.
    c. Buna-nitrile seals.
    d. Acetal collets.
    e. Stainless-steel bolts, nuts, and washers.

2.2 JOINING MATERIALS

A. Joint Compound and Tape shall be suitable for natural-gas.

B. Welding filler metals shall comply with AWS D10.12 for appropriate wall thickness and chemical analysis of steel pipe being welded.

C. Brazing filler metals shall be alloy with a melting point greater than 1000 deg F complying with AWS A5.8. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.3 MANUAL GAS SHUTOFF VALVES

A. General:

1. All types of valves shall be accessible, labeled and specified for use for controlling multiple systems.

2. All valves shall be manually operated and equipped with a handle or lever or operation unless buried. All buried valves shall be operated and equipped with a valve nut or flat head that shall fit a contactor furnished tee-handle.

B. Metallic Valves, NPS 2 and smaller shall comply with ASME B16.33, and have the following characteristics:

1. CWP Rating of 125 psi.
2. Threaded ends complying with ASME B1.20.1.
3. Dryseal threads on flare ends that comply with ASME B1.20.3.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.

C. Metallic Valves, NPS 2-1/2 and larger shall comply with ASME B16.38.

1. CWP Rating of 125 psi.
2. Flanged Ends shall comply with ASME B16.5 for steel flanges.

D. Steel valves shall have capacity to operate in lines with 100 psi working pressure.

1. Valves 1-1/2 inches and smaller installed underground shall conform to ASME B16.34, carbon steel, socket weld ends.
2. Valves 1-1/2 inches and smaller, installed aboveground, shall conform to ASME B16.34, carbon steel, socket weld or threaded ends.
3. Valves 2 inches and larger shall conform to API spec 6D, carbon steel, buttweld ends.
4. Aboveground valves 2 inches or larger shall conform to API Spec 6D, carbon steel, buttweld or flanged ends.
5. Cast iron valves shall conform to ASTM A126, Class B, Type 301 or 302.

E. PE Ball Valves shall comply with ASME B16.40. Valves in sizes 1/2 inch to 6 inches may be used with polyethylene distribution and service lines, in lieu of steel valves, for underground installation only.

1. CWP Rating: 80 psi with an operating temperature of Minus 20 to plus 140 deg F.

F. Valve Boxes shall be cast iron, two-section box.

1. Top section shall include a cover with "GAS" lettering.
2. Bottom section shall have a base to fit over valve and barrel a minimum of 5 inches in diameter.
3. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.4 EARTHQUAKE VALVES

A. Valves shall automatically stop gas flow when actuated by earth tremor and shall be single seated with manual reset. Do not provide manual shut-off attachments.

1. Valve shall comply with ASCE 25 and automatically shut bubble tight within five seconds when subjected to a horizontal sinusoidal oscillation having a peak acceleration of 0.3 gravity with a period of 0.4 seconds. The valve shall not shut-off when subjected for five seconds to horizontal, sinusoidal oscillations having a peak acceleration of 0.4 gravity with a period of 0.1 second; a peak acceleration of 0.08 gravity with a period of 0.4 second or 1.0 second.
2. Valve should be rated for 125 psi with flanged ends for pipe sizes above 2 inches. Valves should have threaded ends for pipe sizes 2 inches and under.
3. Approvals: UL listed, State of California Standards for Earthquake Actuated Automatic Gas Shut-Off Systems.

2.5 VALVE BOXES

A. Provide cast iron extension box with screw or slide type adjustment and flared base. Minimum thickness of metal, 3/16 inch. Box shall be of such length as can be adapted, without full extension, to depth of cover required over pipe at valve location with the word "GAS" in cover.

B. Provide "T" handle socket wrenches of 5/8 inch round stock long enough to extend 2 feet above top of deepest valve box.

2.6 PRESSURE REGULATORS

A. Pressure regulators for individual service lines shall be capable of reducing distribution line pressure to pressures required for users. Ferrous bodies. Regulators should be:

1. Single stage and suitable for natural-gas, having a steel jacket and corrosion-resistant components and elevation compensator. End Connections should be threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators shall comply with ANSI Z21.80a/CSA 6.22a, with a maximum inlet pressure of 100 psi.

C. Line Pressure Regulators shall comply with ANSI Z21.80a/CSA 6.22a with a maximum inlet pressure of 10 psi.

2.7 SERVICE METERS

A. Meters shall comply with Document 40 91 23, Process Measurement Devices and ANSI B109.2.

B. Meters shall be pipe mounted. Meters shall be provided with pressure protection as specified in ASME B31.8 and frost protection.

C. Service-Meter Bars shall be malleable- or cast iron frame for supporting service meter and include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.

1. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

2.8 LABELING AND IDENTIFYING

A. Detectable warning tape shall be acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 PREPARATION

A. Close equipment shutoff valves before turning off natural-gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.2 METALLIC PIPING INSTALLATION

A. Heating trenches, storm and sanitary sewer lines, and water mains shall have right of way.

B. Warning tape shall be continuously placed 12 inches above buried gas lines.

C. Main services and main service shut off valves shall have a 24 inch minimum cover or as recommended by local utility.

D. Service lines shall have an 18 inch minimum cover or as recommended by local utility.

E. Connections between metallic and plastic piping shall be made only outside, underground, and with approved transition fittings.

3.3 NON-METALLIC PIPE INSTALLATION

A. Install pipe in trench in accordance with recommendations of the pipe manufacturer. Provide sufficient slack to allow for expansion and contraction.

B. Joints shall be fusion welds made in accordance with the recommendations of the polyethylene pipe manufacturer. Adhesive joints for fiberglass plastic pipe shall be made in accordance with manufacturer's recommendations.

C. All offsets in piping shall be made with manufactured fittings. Bending of piping to form offsets shall not be permitted.

D. Connections between plastic pipe and metal pipe shall be made in accordance with recommendations of the pipe manufacturer.

E. Copper Tracer Wire consisting of No. 14 AWG solid, single conductor, insulated copper wire shall be installed in the trench with all piping to permit location of the pipe with electronic detectors. The wire shall not be spiraled around the pipe nor taped to the pipe. Wire connections are to be made by stripping the insulation from the wire and soldering with rosin core solder. Solder joints shall be wrapped with rubber tape and electrical tape. At least every 1000 feet, provide a 5 pound magnesium anode attached to the main tracer wire by solder joint shall be wrapped with rubber tape and with electrical tape. An anode shall be attached at the end of each line.

3.4 BUILDING SERVICE LINES

A. Install gas service lines to point of connection within approximately 5 feet outside of buildings to which such service is to be connected and make connections thereto. The point of delivery is the shutoff valve.

B. Connect service lines to top of mains by two-strap service clamp or coupling socket welded to main and into which is screwed a street tee and street elbow swing, joint assembly.

C. The service lines shall be as short and as straight as practicable between the point of delivery and the gas main and shall not be bent or curved laterally unless necessary to avoid obstructions or otherwise permitted. Service lines shall be laid with as few as joints as practicable using standard lengths of pipe. Polyethylene or fiberglass service lines shall not be installed aboveground except as permitted in ANSI B31.8.

D. Install gas service lines to point of connection within approximately 5 feet outside of buildings to which such service is to be connected and make connections thereto. The point of delivery is the shutoff valve.

3.5 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 18 inches below finished grade. Minimum cover depth is 18 inches. Natural-gas piping installed less than 18 inches below finished grade shall be installed in vented containment conduit.

C. Install fittings for changes in direction and branch connections.

3.6 PIPE SLEEVES

A. Pipe shall be continuous through sleeves. Set sleeves in place before concrete is poured. Seal between sleeve/core opening and the pipe with modular mechanical type link seal. All sleeves shall be vented.

B. Provide sleeves where gas lines pass through retaining walls, foundation walls or floors. Split sleeves may be installed where existing lines pass thru new construction.

3.7 SERVICE-METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies aboveground.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of flow meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal bollards to protect meter assemblies as indicated in drawings.

3.8 VALVE INSTALLATION

A. Install underground valves as indicated in drawings.

B. Install regulators with maintenance access space adequate for servicing and testing.

C. Install earthquake valves aboveground outside buildings according to listing.

D. Do not install valves under pavement unless shown on drawings.

E. Clean valve interior before installation.

3.9 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Install tee fitting with capped nipple in bottom to form drip sediment traps. Install as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

A. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 CONCRETE BASES

A. Anchor equipment to concrete base as indicated in drawings.

3.12 PIPE CLEANING

A. All pipe sections shall be blown down with 100 psi air to remove all sand, soil and debris.

B. Blow down procedure shall be done after system is complete, but before valves are installed.

3.13 TESTS

A. Piping System: Inspection, testing and purging shall be in accordance with NFPA 54 and ASME B31.8.

END OF SECTION 335100

SECTION 338000 - PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide precast concrete manholes, catch basins, drop inlets, potable water vaults; meter vaults, and other pre-cast concrete structures complete and in place, in accordance with the Contract Documents.

1.2 RELATED SECTIONS

A. Section 033000 – Cast-in-place Concrete

B. Section 312000 – Earth Moving

1.3 SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

ASTM A 48	Gray Iron Castings.
ASTM C 150	Portland Cement.
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 877	Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
ASTM C 990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.4 CONTRACTOR SUBMITTALS

A. General: Furnish submittals in accordance with Section 013300 - Contractor Submittals.

B. Shop Drawings:

1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
2. Structural design calculations for vaults and boxes shall be stamped and signed by a structural engineer registered in the State of California.

C. Manufacturer’s Certification for Manholes and Vaults: Written certification that the structure complies with the requirements of this Section.

D. Manufacturer’s Test Results: Pull out force for manhole steps.

1.5 QUALITY ASSURANCE

A. Inspection: After installation, the Contractor shall demonstrate that manholes and vaults have been properly installed, level, with water-tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

B. Any precast concrete which arrives on site with voids, cracked, or damaged, or is cracked or damaged during installation shall be cause for rejection. Contractor shall remove precast section(s) from the project site and replace with new undamaged sections at no additional cost to OWNER.

1.6 DELIVERY, STORAGE AND HANDLING

A. Handle precast units in positions consistent with their shape and design. Lift and support only from the support points indicated on the shop drawings.

B. Embedded Lifting or Handling Devices: Capable of supporting units in positions anticipated during manufacturing, storage, transportation and installation.

C. Block and brace units during storage. Provide lateral bracing which is sufficient to prevent bowing and/or warping and will not inhibit curing of the exposed surfaces.

PART 2 - PRODUCTS

2.1 MANHOLES

A. The Contractor shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Cement used in manufacturing the manholes shall be Type II modified Portland cement in accordance with ASTM C 150.

1. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

B. Axial length of sections shall be selected to provide the correct total height with the fewest joints. Joints shall be minimized and shall be located as close as possible to the top of the structure to help minimize opportunity for groundwater infiltration.

C. Conical sections shall have an eccentric shape and shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

D. Design Criteria: Manhole walls, transitions, conical sections, and base shall be designed per ASTM C 478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.
2. Unit weight of soil of 120 pcf located above all portions of the manhole.
3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.
4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.
5. External pressures and uplift forces due to groundwater elevations 2 feet below finish grade.
6. Dead load of manhole sections fully supported by the base and transition.
7. Additional reinforcing steel in walls to transfer stresses at openings.

8. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches or one-half of the diameter of the smaller penetration, whichever is greater.

E. Joints shall have lipped male/female ends which shall provide uniform and continuous interior wall surfaces and shall be watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990.

F. Raw Sewage, Plant Drain, drain manholes, plant effluent and all vaults shall also have each joint wrapped with an external joint sealant meeting ASTM C 877. Concrete for base and channel formation shall be 4000 psi concrete conforming to Section 033000 –Cast-In-Place Concrete.

G. Barrel section to sewer pipe (Raw sewage, plant drain, drain, and plant effluent) connections shall be sealed with flexible resilient connectors complying with ASTM C923 and appropriate for the pipe material being used. Mechanical devices shall be stainless steel.

H. Where required and specified in drawings, manhole steps shall be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches. Furnish test results demonstrating step capability to resist a pull out force of 2200 pounds.

I. Manhole riser sections shall be greater than 12 inches in height.

J. Manhole Manufacturers, or Equal

1. Jensen Precast
2. OLDCASTLE Precast

2.2 FRAMES AND COVERS

A. Castings: Castings for manhole frames, covers, and grates shall be non-rocking with machined flat bearing surfaces, and shall conform to the requirements of ASTM A 48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter. Covers shall have cleated surfaces with pick holes and shall be ventilated in improved areas and have a solid lid design in landscape or native areas.

B. Manhole covers shall be with embossed with lettering saying "Sewer", "Storm Sewer", or “Water”.

C. Unless noted otherwise all frames and covers shall be designed for H-20 traffic loading. Grates and curb inlets in traffic areas shall be designed for H-20 traffic loading.

D. Castings Manufacturers, or Equal

1. 1. D & L Supply
2. Neenah Foundry Co.

2.3 VAULTS

A. The Contractor shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V Portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:

L = 90 h, plus surcharge of 240 psf in areas of vehicular traffic
Where L = loading in psf
h = depth of fill in feet.

D. Unless noted otherwise design loading shall also take into account the lateral and uplift pressure resulting from a groundwater elevation 2 feet below existing grade.

E. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint. All openings through the precast structure shall be reinforced to transfer loads.

1. Joints shall be sealed watertight. All joints (including joints between adjusting rings and manhole structure, other adjusting rings and frame and cover) shall be sealed with a preformed flexible sealant conforming to ASTM C 990. In addition, all joints shall be wrapped with an external joint sealant meeting ASTM C 877.

F. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

G. Covers for access openings shall be provided. Frames for covers shall be fabricated from aluminum, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

H. Where penetrations of the pre-cast concrete vaults are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or wall sleeves, as indicated. Storm drain structures may also use thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. With the exception of vaults on pressurized water system, vaults need not be designed to resist thrust from piping passing through the vault.

I. Lifting holes shall be plugged with a precast concrete plug sealed with a non-shrink grout.

J. Vault Manufacturers, or Equal

1. Jensen Precast,
2. OLDCASTLE Precast

2.4 FABRICATION

A. Maintain plant records and quality control program during fabrication of structural precast concrete sections. Make all quality control records available to Engineer upon request.

B. Use molds that are rigid, and constructed of material that will result in uniform finished surfaces.

C. If self-consolidating concrete is not used, thoroughly vibrate concrete to ensure proper consolidation, elimination of cold joints, and to minimize trapped air on at the concrete surface.

D. Fabricate and provide the required lifting devices which are compatible with embedded components.

E. Ensure reinforcing steel, anchors, inserts, plates, angle and other cast-in items are sufficiently embedded, properly secured, and correctly located. Ensure the reinforcing steel is properly supported to prevent movement or shifting during fabrication. Inadequate concrete cover over reinforcing shall be cause for rejection.

F. Cure precast concrete sections under identical conditions to develop specified concrete quality.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to accepting manholes on site, ensure that manhole meet the requirements of these specifications, are constructed of the correct materials, and are not cracked or damaged in any other way.

B. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the Contractor shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.

C. Buried pre-cast concrete vaults and manholes shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults and manholes shall be set to grade, plumb and level, and oriented to provide the required dimensions and clearances from pipes and other structures.

D. Prior to backfilling vaults, pipe and conduit penetrations and other, openings shall be sealed with polyurethane sealant or as indicated in the drawings. With the authorization of the Engineer, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

3.2 MANHOLES

A. Connect pipe to manhole with flexible connection (unless noted otherwise), as recommended by connection manufacturer. Provide a pipe joint or additional flexible connection 18 inches from the outside of the manhole. Grout around pipe after installation is complete, unless otherwise indicated. All connections shall be watertight.

B. Place top section, cone section or flat slab on top riser section, with the opening positioned over the steps. Top of cone section or flat slab shall be from 10 to 18 inches below finished grade.

C. Install grade rings as required to adjust top of lid and frame to match finish grade elevation. Maximum height of grade rings shall be 12 inches. Maximum number of grade rings shall be two.

D. In paved areas and as indicated in the plans, concrete collars shall be constructed around manhole covers as indicated. Collars shall be of 4000 psi concrete. Collars shall be constructed after pavement has been placed.

E. Steps shall be cast-in-place or vibrated into green concrete.

F. Steps shall be installed 12-inches on centers vertically, not more than 1/2 inch out of plumb. The top step shall be no more then 12-inches below the manhole cover.

G. After manhole base has been completed, furnish and install temporary pipe plugs to seal all interior pipe opening. Plugs shall remain in place until final review and acceptance of completed pipeline. Plugs shall then be removed and shall be property of Contractor.

H. Manhole interiors shall be coated as indicated in the protective coatings schedule.

3.3 QUALITY CONTROL

A. Manholes shall be tested and accepted per the requirements of Section 331400 – Hydraulic Structures Testing. Precast concrete testing is the responsibility of the Contractor and supplier.

B. Do not install precast concrete units until concrete has attained its design compressive strength.

END OF SECTION

SECTION 400500-PIPING, GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, seismic restraints, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.

B. The piping shown is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/ASME B1.20.1	Pipe Threads, General Purpose (inch)
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
ANSI/AWWA C207	Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.
ANSI/AWWA C606	Grooved and Shouldered Joints
ANSI/AWS D1.1	Structural Welding Code
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile
ASTM A 325	Specification for High-Strength Bolts for Structural Steel Joints
ASTM D 792	Test Methods for Specific Gravity and Density of Plastics by Displacement
ASTM D 2000	Classification System for Rubber Products in Automotive Applications

1.3 CONTRACTOR SUBMITTALS

A. Submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in Section 013300 –Contractor Submittals, and as indicated in the individual piping sections. The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design

calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports and seismic restraints necessary to accommodate the equipment and valves provided in a complete and functional system.

B. All expenses incurred in making samples for certification of tests shall be borne by the Contractor at no increased cost to the Owner.

C. Submit as part of the shop drawings a statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.

1.4 QUALITY ASSURANCE

A. Inspection: All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

B. Tests: Except where otherwise indicated, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards. Welds shall be tested as indicated. Perform all tests at no additional cost to the Owner.

C. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

D. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing Work on the pipeline. Machines and electrodes similar to those used in the Work shall be used in qualification tests. Furnish all material and bear the expense of qualifying welders at no increased cost to the Owner.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain perfect pipe joints, supports, or special connections, furnish such assistance at no additional cost to the Owner.

1.6 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

1.7 CLEANUP

A. After completion of the Work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed

over in a clean and functional condition.

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipes, fittings, and appurtenances shall be furnished in accordance with the requirements of the applicable Sections of Divisions 22, 23, 33, 40 and this Section.

B. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of Section 400507 – Hangers and Supports for Process Piping, and as indicated.

C. Lining: All requirements pertaining to thickness, applications, and curing of pipe lining, are in accordance with the requirements of the applicable Sections of Division 40 , unless otherwise indicated.

D. Coating: All requirements pertaining to thickness, application, and curing of pipe coating, are in accordance with the requirements of the applicable Sections of Division 40, unless otherwise indicated. Pipes above ground or in structures shall be field-painted in accordance with Section 098000 – Protective Coatings.

E. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined in Section 330505 - Pipeline Testing, or as indicated on the piping schedule.

F. Grooved Piping Systems: Piping systems with grooved joints and fittings may be provided, if approved by the Engineer, in lieu of screwed, flanged, welded, or mechanical joint systems for steel and ductile iron yard piping above and below ground. All grooved couplings on buried piping must be bonded. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer. The Contractor shall make the coupling manufacturer responsible for the selection of the correct style of coupling and gasket for each individual location.

2.2 PIPE FLANGES

A. Flanges: Where the design pressure is 150 psi or less, flanges shall conform to either ANSI/AWWA C207 Class D or ANSI B16.5 150-pound class. Where the design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E, Class F, or ANSI B16.5 150-pound class. However, AWWA flanges shall not be exposed to test pressures greater than 125 percent of rated capacity. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI B16.5 300-pound class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flanges for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.

B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.

C. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

D. Flange Bolts: Contractor shall supply all bolts and nuts in conformance with Section 055000 – Metal Fabrications. Studs and bolts shall extend through the nuts a minimum of 1/4 inch. All-thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.

E. Insulating Flanges: Insulated flanges shall have bolt holes 1/4 inch diameter greater than the bolt diameter.

F. Insulating Flange Sets: Insulating flange sets shall be provided by the Contractor where shown. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2 inches or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be two-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A 325. Insulating gaskets shall be full-face.

G. Insulating Flange Manufacturers, or Equal
1. JM Red Devil, Type E
2. Maloney Pipeline Products Co., Houston
3. PSI Products, Inc., Burbank, California.

H. Flange Gaskets: Contractor shall provide flange gaskets for all pipe flanges. Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of asbestos-free aramid fiber base, with nitrile binder and nonstick coating, suitable for temperatures to 700 degrees F, a pH of 1 to 11, and pressures to 1,000 psig. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.

I. Flange Gasket Manufacturers, or Equal
1. John Crane, Style 2160.
2. Garlock, Style 3000.

2.3 THREADED INSULATING CONNECTIONS

A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other nonconductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

A. Construction: Cast mechanical-type couplings shall be provided where shown. The couplings shall conform to the requirements of ANSI/AWWA C606. Bolts and nuts shall conform to the requirements of Section 055000 – Metal Fabrications. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the

coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. The Contractor shall have the coupling Manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation.

B. Couplings for Steel Pipe, Manufacturers, or Equal
   1. Victaulic Style 44 with Type D Heavy Duty Grooved Adaptor Ends.

C. Ductile Iron Pipe Couplings, Manufacturers, or Equal
   1. Victaulic Style 31 (flexible or rigid grooving).
   2. Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

D. Couplings for PVC Pipe, Manufacturers, or Equal
   1. Victaulic Style 775.
   2. Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends. Grooved end couplings shall be used on PVC pipe only for Schedule 80 vent piping at the vaults. Grooved end couplings shall not be used for PVC C905 water pipe.

2.5 SLEEVE-TYPE COUPLINGS

A. Construction: Sleeve-type couplings shall be provided where indicated, in accordance with ANSI/AWWA C219 unless otherwise indicated, and shall be of steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings. The middle ring shall be not less than 1/4 inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 055000 – Metal Fabrications. Buried sleeve-type couplings shall be epoxy-coated at the factory.

B. Pipe Preparation: The ends of the pipe, where indicated, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64 inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.

C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer.
   1. The rubber in the gasket shall meet the following specifications:
      a. Color - Jet Black.
      b. Surface - Nonblooming.
      c. Durometer Hardness - 74 " 5.
      d. Tensile Strength - 1,000 psi Minimum.
      e. Elongation - 175 percent Minimum.

2. The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.

E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be in accordance with the requirements of the appropriate reference standard, or as shown.

F. Manufacturers, or Equal
1. Dresser, Style 38.
2. Ford Meter Box Co., Inc., Style FC1 or FC3.
3. Smith-Blair, Style 411.
4. Baker, Series 200

2.6 FLANGED END CONNECTORS

A. Flanged coupling adapters, shall be in accordance with AWWA C219.

B. Dismantling joints for connecting flanged pipe shall be AWWA C219 compliant. Provide studs and nuts to seal gasket separate and independent from tie-bar restraint system.

C. All dismantling joints shall be the restrained type per AWWA M-11. Tie-bar restraint system shall conform to ASTM A193-B7 per AWWA M-11 and be designed to withstand the test pressure shown on the Drawings.

D. All dismantling joints shall use standard flanges in accordance with AWWA C207. The thickness of the dismantling joint flanges shall be equal to or greater than the class of flange that is connected to as required by the test pressure as shown on the drawings. Buried flanges shall be wrapped with petroleum was tape per AWWA C217.

E. Manufacturers, or Equal
1. Smith-Blair, Style 972 or 975
2. Baker, Series DJ

2.7 FLEXIBLE CONNECTORS

A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where shown. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise shown. The connectors shall be 9 inches long, face-to-face flanges, unless otherwise shown. The final material selection shall be approved by the manufacturer. Submit manufacturer's shop drawings and calculations.

2.8 EXPANSION JOINTS

A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement, without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. Submit detailed calculations and manufacturer's shop drawings, guaranteeing satisfactory performance of all proposed expansion joints, piping layouts showing all anchors and guides, and information on materials, temperature and pressure ratings.

2.9 PIPE THREADS

A. All pipe threads shall be in accordance with ANSI/ASME B1.20.1.

2.10 AIR AND GAS TRAPS

A. Air and gas pipes shall be sloping to low points, provided with drip legs, shutoff valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-pound iron body float type with stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.

B. Manufacturers, or Equal
   1. Armstrong Machine Works.
   2. Spirax Sarco, Inc.

PART 3 - EXECUTION

3.1 GENERAL

A. All pipes, fittings, and appurtenances shall be installed in accordance with the requirements of the applicable Sections of Divisions 22 and 40. The lining manufacturer shall take full responsibility for the complete, final product and its application. All pipe ends and joints at screwed flanges shall be epoxy-coated, to assure continuous protection.

B. Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.

C. Flanges shall be installed at least 6-inches from a wall. Fittings shall be installed with sufficient clearance for maintenance and removal and reinstallation.

D. All buried non-metallic piping, 4” and greater, shall have both a marking tape placed 12” above the pipe, and a tracer wire placed on top of the pipe. Tracer wire shall be 12 gauge solid copper wire with a plastic coat to prevent corrosion. The tracer shall be secured to the pipe 10 feet and at all bends. Tracer wire shall not be wrapped around a pipe. Tracer wire installation requires access points at least every 300 feet. At access points the tracer wire is brought up to grade with valve boxes, cleanouts, manholes, vaults, or other covered access devices. Splices in tracer wire should be made with split bolt or compression-type connectors. Wire nuts shall not be used. Testing of tracer wire continuity after installation shall be performed.

END OF SECTION 400500

SECTION 400507 – HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide pipe supports, seismic restraints, hangers, guides, and anchors, complete, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with Section 013300 – Contractor Submittals.

B. Shop Drawings: Shop drawings shall include the following information:
   1. Drawings of pipe supports, restraints, hangers, anchors, and guides
   2. Calculations for special supports and anchors.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Code Compliance: Piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, dislocation due to seismic events and line pressures, and stresses on piping, equipment, and structures. Supports and parts thereof shall conform to the requirements of ASME B31.1 – Power Piping, except as supplemented or modified below. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members: Wherever possible, pipes shall be supported from structural members. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided at no additional cost to the Owner. All supplementary members shall be in accordance with the requirements of the building code and the American Institute of Steel Construction and shall be acceptable to the Engineer.

C. Pipe Hangers: Pipe hangers shall be capable of supporting the pipe in all conditions of operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment. Hangers shall have a means of vertical adjustment after erection. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves, shall include hydraulic shock suppressors. Hanger rods shall be subject to tensile loading only.

D. Hangers Subject to Horizontal Movements: At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement. Where horizontal pipe movement is greater than 1/2-inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold to the hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Spring-Type Hangers: Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping. Spring-type hangers shall be sized to the manufacturer's printed recommendations and the loading conditions encountered. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate at all times the compression of the spring. Supports shall be capable of accommodating at least four times the maximum travel due to thermal expansion.

F. Thermal Expansion: Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely in directions away from the anchored points. Components shall be structurally suitable to withstand loads imposed.

G. Heat Transmission: Supports, hangers, anchors, and guides shall be so designed and insulated, that excessive heat will not be transmitted to the structure or to other equipment.

H. Riser Supports: Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. Freestanding Piping: Free-standing pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to steel frames fabricated from angles, channels, or I-beams anchored to the structure. Exterior, free-standing overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.

J. Materials of Construction:
   1. General: Pipe support assemblies, including framing, shall be steel construction, galvanized after fabrication, with Type 316 stainless steel hardware, and anchors, unless otherwise indicated.
   2. Submerged Supports: Submerged piping, as well as piping, conduits, and equipment in hydraulic structures within 24 inches of the water level, shall be supported with support, assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel, unless otherwise indicated.
   3. Corrosive: Piping in chemical and corrosive areas shall be supported with support assemblies, including framing, hardware, and anchors, constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

K. Point Loads: Any meters, valves, heavy equipment, and other point loads on PVC, FRP, and other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations to avoid undue pipe stresses and failures. To avoid point loads, all supports on PVC, FRP, and other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields.

L. Noise Reduction: To reduce transmission of noise in piping systems, copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar, suitable material at each pipe support, bracket, clip, or hanger.

2.2 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads. Pipe support spacing shall not exceed the maximum spans in the tables below. For temperatures other than ambient temperatures, or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of all loading effects.

1. Support Spacing for Schedule 40 and Schedule 80 Steel Pipe

Nominal Pipe Diameter (inches)	Maximum Span (feet)
1/2	6
3/4 and 1	8
1 - 1/4 to 2	10
3	12
4	14
6	17
8 and 10	19
12 and 14	23
16 and 18	25
20 and Greater	30

2. Support Spacing for Welded Fabricated Steel Pipe

Maximum Spans for Pipe Supported in Minimum **120 degree** contact saddles (feet)

Nominal Pipe Diameter (inches)	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
24	33	37	41	43	45	47				
26	34	38	41	44	46	48				
28	34	38	41	44	47	49				
30	34	38	42	45	48	49				
32	34	39	42	45	48	50				
34	35	39	42	46	48	50				
36	35	39	43	46	49	51	55			
38	35	39	43	46	49	51	55			
40	35	40	43	47	49	52	56			
42	--	40	43	47	50	52	56			
45	--	40	44	47	50	53	57			
48	--	40	44	47	50	53	58	61		
51	--	41	44	48	51	53	58	62		
54	--	41	44	48	51	54	58	62		
57	--	41	44	48	51	54	59	63		
60	--	41	45	48	52	54	59	63	67	70
63	--	41	45	49	52	55	60	64	67	71

66	--	41	45	49	52	55	60	64	68	71
72	--	41	45	49	52	55	61	65	69	72
78	--	41	45	49	53	56	61	66	69	73
84	--	41	46	50	53	56	62	66	70	74
90	--	41	46	50	53	56	62	67	71	74
96	--	42	46	50	54	57	62	67	71	75

3. For steel pipe sizes not presented in this table, the support spacing shall be designed so that the stress on the pipe does not exceed 5,000 psi. Maximum deflection of pipe shall be limited to 1/360th of the span and shall be calculated by using the formula:

$$L = \sqrt{\frac{7500tD}{32t + D}}$$

Where: t = Thickness (inches)
D = Diameter (inches)
L = Maximum span (feet)

4. Support Spacing for Ductile-Iron Pipe:

Normal Pipe Diameter (inches)	Maximum Span (feet)
All diameters	Two supports per pipe length or 10 feet (one of the 2 supports located at joint)

5. Support Spacing for Copper Tubing:

Normal Pipe Diameter (inches)	Maximum Span (feet)
1/2 to 1 - 1/2	6
2 to 4	10
6 and greater	12

6. Support Spacing for Schedule 80 PVC Pipe:

Normal Pipe Diameter (inches)	Maximum Span at 100 degrees F (feet)
1/2	4
3/4	4.5
1	5
1 - 1/4	5.5
1 - 1/2	5.75
2	6.25
3	7.5
4	8.25
6	10
8	11
10	12.25
12	13.25

2.3 MANUFACTURED SUPPORTS

A. Stock Parts: Where not specifically indicated, designs which are generally accepted as exemplifying good engineering practice and use stock or production parts, shall be utilized wherever possible. Such parts shall be locally available, new, of best commercial quality, designed and rated for the intended purpose.

B. Manufacturers, or Equal
   1. Grinnell Corp. (Supply Sales Company), Cranston, RI
   2. Power Piping Company, Pittsburgh, PA.

2.4 COATING

A. Galvanizing: Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Specifications for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

B. Other Coatings: Other than stainless steel or non-ferrous supports, all supports shall receive protective coatings in accordance with the requirements of Section 098000 – Protective Coatings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Pipe supports, seismic restraints, hangers, brackets, anchors, guides, and inserts shall be fabricated and installed in accordance with the manufacturer's printed instructions and ASME B31.1 - Power Piping. Concrete inserts for pipe hangers and supports shall be coordinated with the form work.

B. Appearance: Pipe supports and hangers shall be positioned to produce an orderly, neat piping system. Hanger rods shall be vertical, without offsets. Hangers shall be adjusted to line up groups of pipes at the proper grade for drainage and venting, as close to ceilings or roofs as possible, without interference with other work.

3.2 FABRICATION

A. Quality Control: Pipe hangers, supports, and seismic restraints shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available. Fabricated supports shall be neat in appearance without sharp corners, burrs, and edges.

END OF SECTION 400507

SECTION 400519 – DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish and install all ductile iron pipe, fittings, transitions, connections and appurtenant work, complete and in accordance with the requirements of the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 400500 – Piping, General
B. Section 330505 – Pipeline Testing
C. Section 331400 – Hydraulic Structures Testing

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards:

ANSI/AWWA C104/A21.4	Cement-mortar lining for Ductile Iron and Gray Iron Pipe and Fittings for Water.
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Gray and Ductile Cast Iron Piping for Water and Other Liquids.
ANSI/AWWA C110/A21.10	Fittings, 3-inch through 48-inch for Water and Other Liquids, Gray Iron and Ductile Iron.
ANSI/AWWA C111/A21.11	Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
ANSI/AWWA C115/A21.15	Flanged Ductile Iron and Gray Iron Pipe with Threaded Flanges.
ANSI/AWWA C150/A21.50	Thickness Design of Ductile Iron Pipe.
ANSI/AWWA C153/A21.53	Mechanical Joints (MJ), Push-on joints.
ANSI/AWWA C151/A21.51	Ductile Iron Pipe, Centrifugally Cast, in Metal Molds or Sand Lined Molds for Water and Other Liquids.
ANSI/AWWA C209	Cold Applied Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
ANSI/AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines.
ANSI/AWWA C600	Water Mains and Appurtenances, Installation of Ductile Iron.
ANSI/ASTM D 1248	Polyethylene Lining Material for Ductile Iron Pipe and Fittings.
ASTM C 150	Specification for Portland Cement.
ASTM A 746	Installation of Ductile Iron Pipe for Gravity Sewers.

1.4 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications and as specified in the referenced standards. Certification shall include physical and chemical properties of pipe materials and hydrostatic test reports.

B. All expenses incurred in sampling and testing for certifications shall be borne by the Contractor.

1.5 QUALITY ASSURANCE

A. Ductile iron pipe shall be manufactured with the material, have the dimensions, be within the tolerances and meet the testing requirements set forth in ASTM A746 and ANSI A21.51. Ductile iron pipe shall be manufactured in nominal 18-foot or 20-foot laying lengths and shall have the lining called for in the Contract Documents.

B. All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.

C. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Mortar lined ductile iron pipe shall conform to ANSI/AWWA C151, C104, C105, C214 and D1248, subject to the following supplemental requirements. The pipe shall be of the diameter shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents and all specials and fittings shall be provided as required under the Contract Documents.

B. The pipe shall be handled by use of wide slings, padded cradles or other devices acceptable to the Engineer, designed and constructed to prevent damage to the pipe lining and/or coating. The use of chains, hooks or other equipment which might injure the pipe lining and coating will not be permitted. Stockpiled pipe shall be safely and properly supported to prevent accidental rolling. The Contractor shall be fully liable for the cost of replacement or repair of pipe which is damaged.

C. Maximum pipe laying lengths shall be 20-foot with shorter lengths provided as required by the Drawings.

D. The pipe shall have a smooth dense interior surface and shall be free from fractures, defects and roughness.

2.2 MATERIALS

A. Ductile iron pipe materials shall conform to the requirements of ANSI/AWWA C151/A21.51.

B. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C110/A21.10 or AWWA C153 for diameters 3-inch through 48-inch. Ductile iron fittings larger than 48-inch shall conform to the above referenced standard with the necessary modifications for the larger size.

C. Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104/A21.4; provided, that cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.

D. Glass lined ductile iron pipe and fittings shall be lined with a vitreous material which is hard, smooth, continuous and formulated to prevent the adherence of grease in sludge and scum lines, and to resist the adherence of crystalline metal salt deposits (struvite and vivionite) to sludge and centrate lines in sewage and wastewater treatment plants. It shall be applied to properly prepared pipe and fittings using accepted industry standards, and shall be tested per applicable ASTM, NACE and SSPC standards.

E. Material for the polyethylene encasement shall conform to the requirements of ANSI/AWWA C105/A21.5.

F. All elastomer gaskets used for ductile iron pipe shall be of neoprene or SBR elastomer material with a 1/8" thickness. For high temperature service (process air) gaskets shall be Viton. For high temperature water service gaskets shall be EPDM.

G. All bolts, nuts, and washers, which are buried, submerged or below the top of the wall inside any hydraulic structure used in the assembly of ductile iron pipe and fittings shall be of Type 316 Stainless Steel.

2.3 DESIGN OF PIPE

A. Ductile iron pipe shall be designed in accordance with the requirements of ANSI/AWWA C150/A21.50, as applicable and as modified in this Section. The pipe furnished shall be either mortar-lined or glass-lined as called out in the Contract Documents.

B. The pipe shall be designed, manufactured, tested, inspected and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C151.

C. The pipe and fittings shall be of the diameter shown and shall be of pressure Class 350 for pipe sizes twelve inches and below, pressure Class 250 for pipe fourteen inches to twenty inches, pressure class 200 for twenty-four-inch pipe and pressure class 150 for thirty inch and above, except that where mechanical couplings are used and the pipe is grooved, the ductile iron pipe shall be of special thickness Class 53.

D. Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints and restrained joints as required.

1. All Mechanical and push-on joints may conform to ANSI/AWWA C153/A21.53 or C110/A21.10.
2. Flanged joints shall conform to ANSI/AWWA C115/A21.15.

E. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

2.4 CEMENT-MORTAR LINING

A. Except as otherwise provided herein, interior surfaces of ductile iron pipe, fittings and specials to be furnished with cement-mortar lining shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter (inches)	Minimum Lining Thickness (inches)
3-12	1/8
14-24	3/16
30-54	1/4

C. For all pipe and fittings with plant-applied cement mortar linings, the Contractor shall provide a polyethylene or other suitable bulkhead on the ends of the pipe and on all special openings. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.5 GLASS LINING

A. The lining material shall consist of vitreous and inorganic material applied to the internal surfaces that have been prepared by blasting. The lining shall be applied in a minimum of two (2) coats, separately applied and separately fired. The items shall be exposed to a maturing temperature of approximately 1400 degrees F., at which point the vitreous and inorganic materials melt and fuse to the base metal, forming an integral molecular bond with the base metal surface. Subsequent coatings will be processed in a similar manner, forcing an integral molecular bond with the base coat. The entire finished coating shall be a minimum of 10 mils (.010") as tested with a micro test or other acceptable dry film thickness gauge. The finished lining shall be able to withstand a strain of 0.001 inch/inch (the yield point of the base metal) without damage to the glass. The lining shall be of a light, bright color to allow visual detection of defects more easily prior to electronic holiday detection testing.

B. The lining shall have a hardness of 5-6 on the MOHS scale, and a density of 2.5-3.0 grams per cubic centimeter as measured by ASTM D-792. The glass lining shall be capable of withstanding an instantaneous thermal shock of 350 degrees F. differential without crazing, blistering or spalling. It shall be resistant to corrosion of between PH-3 and PH-10 at 125 degrees F. There shall be no visible loss of surface gloss to the lining after immersing a production sample in an 8% sulfuric acid solution at 148 degrees F. for

a period of 10 minutes. When tested according to ASTM C-283, it shall show a weight loss of not more than 3 milligrams per square inch.

C. Per the recommended industry standards under ASTM D-5162-01, NACE RP 0188-99, and SSPC Coating Manual, Volume 1, Section XIV, the glass lining shall be tested by "low voltage, wet sponge, non-destructive holiday detection unit", with only isolated voids permitted due to casting anomalies. Documentation shall be furnished with each shipment of material listing the test results by identifying "mark" or "tag" numbers.

D. The finished glass lined pipe shall not deviate more than 0.0125 inch per foot of length from a centerline perpendicular to the square pipe end or flange face.

E. The applicator shall have a minimum of 5 years of successful experience in the application of high temperature glass and porcelain coatings for the wastewater and sewage treatment industry. All glass lining of pipe and fittings should be from one manufacturer.

F. All handling and/or lifting of glass lined pipe and fittings must be done on the exterior only. Avoid lifting internally with hooks, forks or chains at any time.

2.5 EXTERIOR COATING OF PIPE

A. The exterior surfaces of ductile iron pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 098000 entitled, "Protective Coating." This exposed piping shall not be coated with the bituminous coating by the manufacturer prior to delivery.

B. Buried ductile iron pipe shall be pipe shall be epoxy-coated according to requirements of Section 098000 "Protective Coatings".

C. Submerged ductile iron pipe shall be epoxy-coated according to requirements of Section 098000 "Protective Coatings".

2.5 RESTRAINED JOINTS

A. Restrained joints shall conform to either ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53.

B. Restraint devices for pipe sizes 3" – 48" shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. The devices shall have a working pressure rating of 350 psi for 3"-16" and 250 psi for 18"-48". Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes.

C. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536. For applications requiring restraint 30" and greater, an alternate grade of iron meeting the material requirements of ASTM A536 is acceptable, providing the device meets all end product performance requirements. Ductile iron gripping wedges shall be heat treated within a range of 370 to 470 BHN.

D. Three (3) test bars shall be incrementally poured per production shift as per UL specifications and ASTM A536. Testing for tensile, yield and elongation shall be done in accordance with ASTM E8. Chemical and nodularity tests shall be performed as recommended by the Ductile Iron Society, on a per ladle basis.

E. Mechanical joint restraint for ductile iron pipe shall be produced by EBAA Iron, Inc and shall be:

a. Megalug Series 1100 for Fittings
b. Megalug Series 1700 for Joints
c. Megalug Series 3800 for Couplings

F. Finish shall be Megabond, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE

A. All pipe, fittings, etc. shall be carefully handled and protected against damage, impact shocks and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site in accordance with Paragraph 2.1B, herein. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

B. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe. No pipe shall be installed where the lining or coating show defects that may be harmful as determined by the Engineer. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.

C. The pipe shall be installed in accordance with ANSI/AWWA C600. Before placement of the pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work. As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, rocks and any other debris following completion of pipe laying prior to testing and disinfecting the completed pipeline.

D. Pipe shall be laid directly on the imported bedding material. No blocking will be permitted and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent joint loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

E. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be

made by the deflection of joints, by the use of bevel adapters or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer.

F. No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

G. The openings of all pipe and specials where the pipe and specials have been cement-mortar lined in the shop shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

H. Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

I. All valves shall be handled in a manner to prevent any injury to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to ensure proper operation. All valves shall be installed so that the valve stems are plumb and in the location shown.

K. All buried bolts shall be coated with FM grease prior to applying the polyethylene wrap.

END OF SECTION 400519

SECTION 400523 - STAINLESS STEEL PIPING AND TUBING

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide stainless steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 400500 – Piping, General apply to the Work of this Section.

1.2 DESIGN REQUIREMENTS

A. Piping Layout: Layout and fabricate piping systems with piping sections as long as possible, while still allowing shipment, so that joints made up in the field are minimized. Piping layout shall not rely on field welding, which is prohibited except as authorized by Engineer for special circumstances.
   1. Piping design indicated on the Drawings illustrates piping layout and configuration and does not indicate the location of every field joint and flexible coupling that may be needed to connect piping sections fabricated in the shop.
   2. Add joints and flexible couplings in a manner that achieves intent of maximizing size of individual piping sections.
   3. Obtain acceptance of Engineer for joints and connectors prior to fabrication.

B. Shop Fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture.

C. Field Assembly: Assemble shop-fabricated piping in the field using the joints designed into the piping layout or by using flexible couplings. Field welding is prohibited, unless written authorization is provided by the Engineer.

1.3 SUBMITTALS

A. Layout Drawings: Provide detailed layout drawings showing dimensions and alignment of pipes; location of valves, fittings, and appurtenances; location of field joints and couplings; location of pipe hangars and supports; connections to equipment or structures; location and details of shop welds; and thickness and dimensions of fittings and gaskets.
   1. Prepare layout drawings using latest version of AutoCAD.
   2. Submit AutoCAD files after layout drawings have been reviewed and accepted by Engineer.

B. Product Data: Provide the following:
   1. Photographs, drawings, and descriptions of pipe, fittings, welding procedures, and pickling and passivating procedures.
   2. Material specifications for pipe, gaskets, fittings, and couplings.
   3. Data on joint types and components used in the system including stub ends, backing flanges, flanged joints, grooved joint couplings and screwed joints.

C. Manufacturing certifications.

D. Welder and weld operator qualification certificates and welding procedures. A schedule of weld operators and identification symbols, as required in Article 2.01 F. Field welding references.

PART 2 - PRODUCTS

2.1 PIPE MATERIAL

A. General:
1. Pipe sizes specified in the Specifications and indicated on the Drawings are nominal.

B. Wall Thickness:
1. As specified in the piping schedule.

C. Piping Material and Manufacturing: Comply with the requirements outlined in the following table (unless otherwise specifically noted in the Drawings):

Service	**Stainless Steel Grade**	**Pipe Manufacturing Process**
Piping 3 inches in nominal diameter and larger	Type 304L stainless steel conforming to ASTM A 240	In accordance with ASTM A 778
Piping less than 3 inches in nominal diameter	Type 304L stainless steel conforming to ASTM A 240	In accordance with ASTM A 312

D. Fittings for Piping 3 inches in Nominal Diameter and Greater:
1. Material: ASTM A 240 stainless steel, grade to match the pipe.
2. Manufacturing Standard: ASTM A 774.
3. Wall Thickness of Fitting: In accordance with ANSI B 36.19 for the schedule of pipe specified.
4. End Configuration: As needed to comply with specified type of joint.
5. Dimensional Standards:
   a. Fittings with Weld Ends: In accordance with ANSI B 16.9.
   b. Fittings with Flanged Ends: In accordance with ANSI B16.5, Class 150.

E. Fittings for Piping Less than 3 inches in Diameter:
1. Material: ASTM A 240 stainless steel, grade to match the pipe.
2. Manufacturing Standard: ASTM A 403, Class WP.
3. Wall Thickness and Dimensions of Fitting: In accordance with ANSI B16.3 or ANSI B16.9 as appropriate and as required for the schedule of pipe specified.
4. End Configuration: As needed to comply with specified type of joint.
5. Forgings conforming to ASTM A182, Grade F304 or Grade F316; or barstock conforming to ASTM A276, Type 304 or Type 316. Forging or barstock material shall match the piping materials.

F. Piping Joints:
1. Joint Types, Piping Greater than 2 Inches in Diameter, General:
   a. Where type of joint is specifically indicated on the Drawings or specified, design and shop-fabricate piping sections utilizing type of joint illustrated or scheduled.
   b. Where type of joint is not specifically indicated on the Drawings or specified in the Piping Schedule, design and shop-fabricate piping sections utilizing any of the following joint types:
      1) Piping stub ends with backing flanges.

2) Welded joints.
3) Flanged joints.

c. Joints at Valves and Pipe Appurtenances: Provide flanged valves and flanged pipe appurtenances in stainless steel piping systems with flanged ends. Design and fabricate piping sections to make connections with flanged valves and pipe appurtenances using piping stub ends with backing flanges, flanged coupling adapters or flanged joints.

1) Flexible Couplings and Flanged Coupling Adapters: Provide stainless steel construction with materials matching the piping system, Dresser Industries, Style 38 or equal.

2. Joints in Piping 2 Inches in Diameter and Smaller: Flanged or screwed with Teflon tape thread lubricant.
3. Welded Joints:
   a. Pipe 12 Inches and Larger in Diameter: Automatically weld joints using gas tungsten-arc procedures.
   b. Piping 4 Inches Through 12 Inches in Diameter: Double butt welded joints
   c. Piping less than 4 Inches in Diameter: Single butt-welded joints.
4. Flanged Joints: Conforming to the requirements of ANSI B16.5, Class 150.
5. Piping Stub Ends and Backing Flanges for Pipe 3 inches and Larger:
   a. Piping Stub Ends: Cast Type 304L or 316L stainless steel to match the pipe material with machined gasket and wetted surfaces of stub ends free of crevices, pits, cracks and protrusions. Manufacturers: Alaskan Copper Works, Figure SK-38 or equal.
   b. Backing Flanges: Cast or forged Type 304 stainless steel with drilled bolt patterns conforming to ANSI B16.1, Class 125 or ANSI B16.5, Class 150. Manufacturers: Alaskan Copper Works, Figure SK-39 or equal.
6. Flanges for Schedule 10s, 40s and 80S Pipe:
   a. Provide forged Type 316L stainless steel welding neck flanges or slip-on flanges conforming to ANSI B16.5 Class 150.
   b. Material shall conform to ASTM A182.
7. Grooved Joints: Rigid type with rolled grooves.
   a. Pipe and fittings roll grooved to conform with AWWA C 220.
   b. Grooving may be accomplished in factory or in field.
   c. Couplings: Rigid type, cast from ductile iron, Victaulic Style 07 or equal. Coat per Section 098000 – Protective Coatings

G. Gaskets:
1. Aeration Air Service: Unless noted otherwise - EPDM, suitable for temperatures up to 250 °F, 1/8-inch thick (minimum), 60 shore hardness, smooth surface. Garlock Style 8314 or equal.
2. All Other Service Applications: EPDM, nitrile, or other materials compatible with the process fluid.

H. Bolts for Flanges and Stub End/Backing Flanges: In compliance with ASTM A193 heavy hex head. Length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut. Nuts shall comply with ASTM A194 heavy hex pattern. Bolts, nuts, and washers shall be Type 316 stainless steel.

I. Fabrication of Pipe Sections:

1. Welding: Weld in accordance with Section 05 50 00 and using electrodes and techniques in accordance with AWS D10.4.
2. Weld Seams:
    a. Full penetration welds, free of oxidation, crevices, pits and cracks and without undercuts.
    b. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.
    c. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.
    d. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

J. Pickling and Passivation:
1. Following shop fabrication of pipe sections, straight spools, fittings and other piping components, pickle and passivate fabricated pieces.
2. Immerse fabricated pieces in sulfuric acid solution followed by immersion in a nitric-hydrofluoric bath and subsequent wash at the proper temperature and length of time.
3. Finish Requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.

2.2 STAINLESS STEEL TUBING

A. Stainless Steel Tubing: Seamless tubing made of Type 316L stainless steel and conforming to ASTM A 269, wall thickness not less than 0.065 inches.

B. Fittings: Swage ferrule design with components made of Type 316 stainless steel.
1. Double acting ferrule design, providing both a primary seal and a secondary bearing force.
2. Flare, bite, or compression type fittings are not acceptable.
3. Manufacturers: One of the following or equal:
    a. Crawford Fitting Company, Swagelok.
    b. Hoke, Gyrolok.
    c. Parker, CPI.

C. Valves for Use with Stainless Steel Tubing:
1. Ball type valves with swage ends to match tubing diameter.
2. Type 316 / 316L stainless steel with TFE seats.
3. Manufacturers: Apollo, Nupro or equal.

2.3 SOURCE QUALITY CONTROL

A. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

B. Provide written certification that the pipe as supplied conforms to the requirements of ASTM A778. Supplemental testing is not required.

C. Provide written certification that the fittings as supplied conform to the requirements of ASTM A774. Supplementary testing is not required.

PART 3 - EXECUTION

3.1 PIPE PREPARATION

A. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true. Ends of threaded pipes shall be reamed and filed smooth. Pipe fittings shall be equally cleaned before assembly.

3.2 INSTALLATION

A. General: Stainless steel pipe shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary all piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. Installation shall be acceptable to the Engineer.

B. Supports and Anchors: Piping shall be firmly supported with fabricated or commercial hangers or supports in accordance with Section 40 00 01 – Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

C. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

D. Protection: Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the Work.
   1. Handling methods and equipment used shall prevent damage to the coating and shall include the use of wide canvas slings and wide padded skids.
   2. Bare cables, chains, hooks, metal bars, or narrow skids shall not be used.

3.3 PIPE JOINTS

A. Threaded Joints: Pipe threads shall conform to ANSI/ASME B 1.20.1 – Pipe Threads, General Purpose (inch), and shall be full and cleanly cut with sharp dies. Not more than three threads shall remain exposed after installation.

B. Welded Joints: Welded joints shall conform to the specifications and recommendations of ANSI/ASME B 31.1 – Power Piping. Welding shall be done by skilled and qualified welders per Section 40 05 00 – Piping, General.
   1. Field welding is prohibited unless written authorization is provided. Pipe butt welds may be performed at the Site, if authorized by the Engineer, providing the butt welds are performed only with an inert gas shielded process and that other indicated welding requirements are followed rigidly.
   2. Residue, oxide, and heat stain shall be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning, inside and outside of pipe, with an agent such as Eutectic Company's "Euclean" or equal, followed by complete removal of the agent.

C. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the manufacturer's recommendations and conforming to ANSI/AWWA C606. Grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

3.4 INSPECTION AND FIELD TESTING

A. Inspection: The finished installation shall be carefully inspected for proper supports, anchoring, interferences, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.

B. Field Testing: Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule, for a period of not less than one hour, without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish all test equipment, labor, materials, and devices at no extra cost to the Owner.

1. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.
2. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re-tested until no leaks are found.

END OF SECTION 400523

SECTION 400531 - PLASTIC PROCESS PIPE

PART 1 - GENERAL

1.1 THE REQUIREMENT:

A. The Contractor shall furnish and install all PVC and polyethylene plastic pipe, fittings, transitions, connections and appurtenant work, complete and in accordance with the requirements of the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Earth Moving. Section 312000

B. Pipeline Testing. Section 330505

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS:

A. Commercial Standards:

ASTM D 1784 and ASTM D 1785	Specifications for Polyvinyl Chloride (PVC) Plastic Pressure Pipe and Solvents
ASTM D 3034	Specifications for Polyvinyl Chloride (PVC) Plastic Gravity Sewer Pipe
ASTM D 2321	Standard Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
ASTM F894	Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.
ASTM D3350	Specification for Polyethylene Plastics Pipe and Fittings Materials.

1.4 CONTRACTOR SUBMITTALS:

A. Contractor shall submit copies of the manufacturer's product specifications according to the requirements of Section 013300 entitled, "Contractor Submittals".

PART 2 - PRODUCTS

2.1 PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, 24-INCH DIAMETER AND SMALLER - SOLVENT WELDED

A. PVC pressure pipe 24-inches and smaller shall be made from all new rigid un-plasticized polyvinyl chloride and shall be Normal Impact Class 12454-B, Schedule 80, to conform to ASTM D 1785, unless otherwise shown. Elbows and tees shall be of the same material and schedule as the pipe. Unless otherwise shown, joint design shall be for solvent-welded construction.

B. Solvent welded PVC and CPVC joints shall utilize heavy solvent welding glue, suitable for chemical exposure applications including sodium hypochlorite solution (up to 20%

concentration) and sodium bisulfate solution (up to 50% concentration). Solvents shall meet ASTM F 493, ASTM D 2846, ASTM D 2564 standards and SCAQMD Rule 1168/316A. PVC solvent weld shall be WELD-ON brand as manufactured by IPS Corporation or equal. Installation shall conform to ASMT D-2855 and manufacturer instructions. The following solvents are provided for reference, Contractor shall confirm appropriate installation and application with the solvent supplier:

Up to 12" PVC (schedule 40 or 80): Weld-On 711 & 717
Up to 30" PVC (schedule 40 or 80): Weld On 719
Up to 12" CPVC (schedule 40 or 80): Weld-On 714 & 724
Up to 30" CPVC (schedule 40 or 80): Weld-On 729

C. Contractor shall apply primers (Weld-On P-70) and prepare the solvent welded joints as recommended by the manufacturer.

2.2 CPVC (CHORINATED POLYVINYL CHLORIDE) PRESSURE PIPE, 8-INCHES AND SMALLER – SOLVENT WELDED

D. All CPVC pipe shall be made from all new rigid, un-plasticized Type IV, Grade I Chlorinated Polyvinyl Chloride (CPVC) compound with a cell classification of 23447, Schedule 80, per ASTM D 1784. The pipe shall be manufactured in compliance to ASTM F441, meeting all requirements with regard to material, workmanship, burst pressure, flattening, and extrusion quality.

E. Solvent welded PVC and CPVC joints shall utilize heavy solvent welding glue, suitable for chemical exposure applications. Solvents shall meet ASTM F 493, ASTM D 2846, ASTM D 2564 standards and SCAQMD Rule 1168/316A. PVC solvent weld shall be WELD-ON brand as manufactured by IPS Corporation or equal. Installation shall conform to ASTM D-2855 and manufacturer instructions. The following solvents are recommended by IPS Corporation

Up to 12" PVC (schedule 40 or 80): Weld-On 711 & 717
Up to 30" PVC (schedule 40 or 80): Weld-On 719
Up to 12" CPVC (schedule 40 or 80): Weld-On 714 & 724
Up to 24" CPVC (schedule 40 or 80): Weld-On 729

Contractor shall consult with solvent manufacturer to ensure proper use and application for each pipe size required in the design drawings. Contractor shall apply primers (Weld-On P-70) and prepare the solvent welded joints as recommended by the manufacturer.

2.3 DOUBLE WALL CONTAINMENT PVC AND CPVC PIPING AND FITTINGS – SOLVENT WELDED

A. Contractor shall furnish a complete double-containment piping system including piping, fittings, anchors, terminations, and other appurtenances. Containment piping shall conform to the following standards:

ASTM D 1784
ASTM D 1970
ASTM F 437

ASTM F 439
ASTM F 441

B. All double containment pipe for buried chemical service shall consist of an outer containment pipe of Schedule 80 PVC or CPVC by an inner product pipe of Schedule 80 PVC or CPVC pipe, material as specified in the design drawings and pipe schedules. Containment pipe shall be at least 2 sizes larger than product pipe. Transition to single wall piping must be above the finished grade or floor.

C. Where joining to existing below grade containment lines (pipe in a pipe style containment lines), contractor shall utilize CPVC couplers, bushings, or fittings as necessary to connect the new containment pipe to the existing containment pipe lines. Note that existing lines may utilize different containment line diameter sizes than that of the new containment pipe. Contractor shall coordinate couplings and tie-ins to existing containment pipe with the containment pipe supplier.

D. Containment PVC and CPVC pipe shall be:

1. Asahi/America – Pro-Lock
2. IPS Flow Systems - Duo-Safe
3. Or Equal

E. For transition from double containment below grade service to single wall above grade service, provide a cap to cover and prevent water, debris or other items from falling into the containment pipe.

F. Solvent welded PVC and CPVC joints shall utilize heavy solvent welding glue, suitable for chemical exposure applications. Solvents shall meet ASTM F 493, ASTM D 2846, ASTM D 2564 standards and SCAQMD Rule 1168/316A. PVC solvent weld shall be WELD-ON brand as manufactured by IPS Corporation or equal. Installation shall conform to ASTM D-2855 and manufacturer instructions. The following solvents are recommended by IPS Corporation:

Up to 12” PVC (schedule 40 or 80): Weld-On 711 & 717
Up to 30” PVC (schedule 40 or 80): Weld-On 719
Up to 12” CPVC (schedule 40 or 80): Weld-On 714 & 724
Up to 24” CPVC (schedule 40 or 80): Weld-On 729

Contractor shall consult with solvent manufacturer to ensure proper use and application for each pipe size required in the design drawings. Contractor shall apply primers (Weld-On P-70) and prepare the solvent welded joints as recommended by the manufacturer. Contractor shall also consult with the containment pipe supplier regarding solvent welding procedures.

2.4 AWWA C-900 PLASTIC PIPE (4”-12”)

A. Pipe shall meet the requirements of AWWA C900 “Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-Inch through 12-Inch with maximum DR of 18 unless noted otherwise.

B. Provisions must be made for expansion and contraction at each joint with an elastomeric seal.

C. The bell shall consist of an integral thickened wall section with an elastomeric seal. The wall thickness in the bell section shall conform to the requirements of Section 6.2 of ASTM D3139, "Standard Specification for Joint for Plastic Pressure Pipes Using Flexible Elastomeric Seals."

D. When used for potable water systems, pipe shall meet the requirements of ANSI/NSF 61 "Drinking Water System Components – Health Effects."

E. The pipe shall be manufactured to cast iron outside diameters (CIOD) in accordance with AWWA C900.

F. The seal shall meet the requirement of ASTM F477 "Standard for Elastomeric Seals (Gaskets) for Joining Plastic Pipe."

G. All fittings shall be ductile iron fittings, as required in Section 400519.

2.5 AWWA C-905 PLASTIC PIPE (14"-42")

A. Material: PVC compound shall meet Cell Class 12454 per ASTM D 1784 and shall be certified to ANSI/NSF Standard 61 for potability.

B. Pipe shall meet AWWA C905 with a maximum DR of 41 and shall be UL listed.

C. Elastomeric Seal: Integral bell pipe shall be provided with factory-installed gaskets, which meet the requirements of ASTM F 477.

D. Gasketed joint assembly shall meet the requirements of ASTM D 3139.

E. All fittings shall be ductile iron fittings, as required in Section 400519.

2.6 DRAIN WASTE VENT PIPE (PVC DR-35 ½" – 8")

A. Pipe shall be extruded from PVC Compound having a minimum Cell Classification 12454B as defined in ASTM D 1784. Belled end shall conform to ASTM D 2672, "Joints for PVC Pipe Using Solvent Cements", and shall conform to ASTM D 2855.

2.7 RESTRAINED JOINTS

A. Restrained joints shall conform to either ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53.

B. Restraint devices for pipe sizes 3" – 48" shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10. The devices shall have a working pressure rating of 350 psi for 3"-16" and 250 psi for 18"-48". Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes.

C. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536. For applications requiring restraint 30" and greater, an alternate grade of iron meeting the material requirements of ASTM A536 is acceptable, providing the device meets all end product performance requirements. Ductile iron gripping wedges shall be heat treated within a range of 370 to 470 BHN.

D. Three (3) test bars shall be incrementally poured per production shift as per UL specifications and ASTM A536. Testing for tensile, yield and elongation shall be done in accordance with ASTM E8. Chemical and nodularity tests shall be performed as recommended by the Ductile Iron Society, on a per ladle basis.

E. Mechanical joint restraint for PVC pipe shall be:

1. Megalug Series 2000 or 2200 produced by EBAA Iron Inc. or equal for fittings.
2. Megalug Series 1900 or 2800 produced by EBAA Iron Inc. or equal for joints.

F. Finish coating shall be Megabond, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE:

A. All pipe, fittings, etc. shall be carefully handled and protected against damage, impact shocks and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground, but shall be supported in a manner which will protect the pipe against injury whenever stored at the work site. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

B. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe. Damaged pipe shall be replaced with new undamaged sections of pipe.

C. Before placement of the pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work. As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, rocks and any other debris following completion of pipe laying prior to testing, disinfecting and placing the completed pipeline in service.

D. Pipe shall be laid directly on the imported bedding material. No blocking will be permitted and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Bell holes shall be formed at the ends of the pipe to prevent joint loading at the bells or couplings.

E. Where necessary to raise or lower the pipe grade due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints or by the use of additional fittings. However, in no case

shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer.

F. No pipe shall be installed upon a foundation into which frost has penetrated or any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

G. Immediately before jointing bell and spigot pipe, both the bell and spigot end of the pipe shall be thoroughly cleaned and lubricated with an approved vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper alignment. Tilting of the pipe to insert the spigot into the bell will not be permitted.

H. Solvent-welded and heat-fused joints shall be carefully and thoroughly cleaned immediately before jointing the pipe. Particular care shall be taken in making solvent-welded joints to ensure a uniform, homogeneous and complete bond.

END OF SECTION 400531

SECTION 400533 - HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall provide high density polyethylene pipe and appurtenances, complete in place, in accordance with the Contract Documents.

1.2 RELATED SECTION

A. Section 312000 – Earth Moving

1.3 REFERENCES

A. The Materials and Work furnished shall be, as a minimum, in accordance with the latest editions of the following standards except as such Standard are modified and supplemented in this section.

AWWA C906	Standard for Polyethylene (PE) Pressure Pipe & Fittings, 4 inch (100 mm) through 63 inch (1,575 mm) for Water Distribution and Transmission
ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM D3035	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM D256	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D2683	Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM F1055	Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
ASTM D2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM F2164	Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure

ASTM F1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
PPI TR-33	Generic Butt Fusion Joining Procedure for Field Joining of PE Pipe

1.4 SUBMITTALS

A. The Contractor shall submit the following information and data. See Section 013300 – Contractor Submittals.

1. Product Data: Provide data indicating pipe, pipe accessories and fittings.
2. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.
3. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
4. Certified Resin Test Reports covering the physical, stress, regression, thermal and impact tests of resin material to be used for the pipe. Submit this information prior to manufacturing or fabricating any pipe.
5. Proposed butt fusion procedures including training and qualification requirements and joint repair procedures shall be submitted to the Engineer for review and approval.
6. Qualifications of Butt Fusion Welders and Welding Operators
    a. All butt fusion welders and welding operators shall be qualified and certified for all portions of the work specified in this section. Welder qualification requires that during the past 12 months all welders and welding operators have successfully completed certified butt-fusion joints using the pipe and welding machine proposed for this project.
    b. Current welder and welding operator performance qualification test records shall be submitted to the Engineer for review and approval prior to commencing field operations.
    c. Personnel that will be operating the butt fusion welder shall be certified by either 1 and 3, or 2 and 3 of the following criteria:
        1) Previous demonstrated experience during the past 12 months, in the use of the procedure on similar projects using the same welding machines and type of pipe proposed.
        2) Appropriate training and apprenticeship
        3) All operators shall make a specimen joint from the pipe to be used on the project. This joint shall then be subjected to the test requirements specified herein.
7. Fusion parameters including the recommended limits of all criteria recorded by the data logger.
8. Fusion report for each joint, which shall include the following information.
    a. Pipe size and dimensions
    b. Machine size
    c. Operator identification
    d. Job identification number
    e. Weld number
    f. Fusion, heating and drag resistance settings
    g. Heater plate temperature
    h. Time Stamp
    i. Heating and curing time of weld
    j. Curing temperature readings and time stamps of readings
    k. Ambient air temperature and humidity

l. Error message and warnings for out of range temperature or pressure settings.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable codes for materials and installation of the Work in this Section.

1.6 PROJECT CONDITIONS

A. Coordinate the Work on existing utility lines and connections to existing utility lines with the Owner.

1.7 QUALITY CONTROL

A. Any pipe manufactured prior to review and approval of all required prefabrication submittals will be at the Contractor's own risk.

B. Review of the Contractor's shop drawings shall not relieve the Contractor of any responsibility for accuracy of dimensions and details, nor shall mutual Agreement of dimensions or details relieve the Contractor of responsibility for Agreement and conformity of its Shop Drawings with the Contract.

1.8 QUALITY ASSURANCE

A. Fabrication, processing, testing and inspection operations affecting the pipe and associated accessories shall, at any time, be subject to quality assurance surveillance by Owner, or Engineer. Such surveillance shall be at the discretion of the Owner. Such surveillance does not relieve the Contractor from responsibility for the Work.

B. All deviations from this specification section must be documented and referred to Engineer for resolution.

C. The Contractor shall submit to the Engineer an affidavit from the manufacturer that the pipe, specials, fittings, and other products of material furnished under this Contract comply with all applicable provisions of AWWA C906 standards and this specification.

D. DOCUMENTATION: The following items shall be documented and stored as part of the manufacturer's permanent records. Copies of all documentation shall be provided to the Engineer.
   1. Documentation from the resin's manufacturer showing results of the following tests for resin identification:
      a. Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer, ASTM D1238
      b. Standard Test Method for Density of Plastics by the Density - Gradient Technique, ASTM D1505
   2. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined in accordance with ASTM D2837.

3. Production staff shall check each length of pipe produced for the items listed below. The results of all measurements shall be recorded on production sheets, which becomes part of the manufacturer's permanent records.
    a. Pipe in process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc.)
    b. Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM D3035.
    c. Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference at both ends of the pipe to ensure conformance with ASTM D3035.
    d. Pipe length shall be measured.
    e. Pipe marking shall be examined and checked for accuracy.
    f. Pipe ends shall be checked to ensure they are cut square and clean.
    g. Subject inside surface to a "reverse bend test" to ensure the pipe is free of oxidation (brittleness).
    h. Copies of all manufacturer documentation shall be submitted to the Engineer for review and approval upon completion of manufacturing.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished as a part of the Work.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Contractor shall comply with the following minimum requirements:
1. Referenced standards for all materials, processes, methods, tests, etc to be used in completion of the Work.
2. Delivery of all pipe and materials, all aspects of which shall be conducted in such a manner as to minimize handling, provide proper weather protection and storage, and to meet schedule requirements.
3. Furnish and use load rated nylon-type slings for securing, lifting, and unloading pipe sections; or, the use of acceptable protective wraps to minimize damage from the alternate rigging equipment.
4. Internal timber bracing shall be provided to maintain pipe shape and integrity throughout plant storage, transportation, and site storage operations through installation and backfill placement. Internal bracing shall not be removed until a minimum of 2 feet of compacted trench zone material is placed above the top of the pipe.

2.2 MANUFACTURER

A. All HDPE pipe and HDPE fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications. Qualified manufacturers shall be: PLEXCO Division of Chevron Phillips Chemical Company, DRISCOPIPE as manufactured by Chevron Phillips Co., Inc., WL Plastics or equal.

2.3 PIPE IDENTIFICATION

A. The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5-feet:
   1. Name and/or trademark of the pipe manufacturer.
   2. Nominal pipe size.
   3. Dimension ratio.
   4. The letters PE followed by the polyethylene grade in accordance with ASTM
   5. D1248 followed by the hydrostatic design basis of 1600 psi, e.g., PE 4710.
   6. Manufacturing standard reference, e.g., ASTM D-3035, as required.
   7. A production code from which the date and place of manufacture can be determined.
   8. Color Identification, either striped by co-extruding longitudinal identifiable color markings or shall be solid in color and as follows:
      a. BLUE – Potable Water
      b. GREEN – Sanitary Sewer
      c. PURPLE – Utility Water

B. Marking Tape: Marking tape shall be provided and installed as shown in Drawings and per Engineer approval.

2.4 COMPATIBILITY

A. Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.

2.5 WARRANTY

A. The pipe Manufacturer shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the Owner. The Manufacturer shall replace at no expense to the Owner any defective pipe/fitting material including labor within the warranty period.

2.6 MATERIALS

A. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 4710 high density polyethylene resin compound meeting a minimum cell classification 445574C per ASTM D3350 and ASTM F714.

B. High Density Polyethylene (HDPE) pipe shall be manufactured in accordance with AWWA C901-96 for sizes ½-inch through 3-inch diameters and to the requirements of ASTM D 3035. Pipe 4-inches and above shall be manufactured to the requirements of ASTM F714 and AWWA C906-99.

C. Unless otherwise noted, diameters shown in the Contract Documents shall refer to Iron Pipe Size (IPS) system conforming to the requirements of AWWA C906.

D. If rework compounds are required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used. Clean rework material of the same type grade, and cell classification generated from the manufacturers own pipe and fitting production may be used by the same manufacturer as long as the pipe, tubing and fittings produced meet all requirements of AWWA C906.

E. Dimensions and workmanship shall be as specified by ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a range of density 0.956-0.964 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi at 73.0°F in accordance with ASTM D2837.

F. The extruded pipe shall have impact strengths greater than 42 in-lb/in in accordance with ASTM D256 Method A, with a material thickness representative of the cross-section in which the material is to be used.

G. Pipe and fitings used for potable water applications shall be NSF 61 certified.

H. The pipe Manufacturer shall certify compliance with the above requirements.

2.7 FABRICATION

A. Pipe shall be homogenous throughout and uniform in color, opacity, density and other properties as prescribed in the Resin Manufacturers Specifications. The inside and outside surfaces shall be semi-matte to glossy in appearance and free from sticky or tacky material. The pipe walls shall be free from cuts, cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the naked eye that may affect wall integrity.

B. Pipe dimensions and wall thickness variations shall be in conformance with requirements of AWWA C906.

C. Pipe shall be finished smooth throughout all inside surfaces and true to all specified tolerances circumference and diameter such that: The difference between maximum and minimum diameters, at any cross-section along the length of the pipe does not exceed 1% of the nominal diameter.

D. Special pipe sections, fittings, and special pieces shall be completely fabricated in the shop. All pipe fittings shall be fabricated or molded to correct dimensions throughout the entire length. Ends cuts shall be clean, squarely-made, and suitable for field welding, without drawn, ragged, gouged, or split ends.

E. All HDPE fittings, unless noted otherwise on the drawings shall be fabricated in conformance with the requirements of AWWA C906. Molded fittings shall meet the requirements of ASTM D3261 for butt-type fittings and this specification.

2.8 FITTINGS

A. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.

B. Polyethylene fittings furnished under this specification shall be manufactured using compounds complying with the requirements of HDPE pipe above and all appropriate requirements of AWWA C906. Socket fittings shall comply with ASTM D2683, Butt Fusion fittings shall comply with ASTM D3261. Electrofusion fittings shall comply with ASTM F1055. Mechanical fittings (e.g. back-up rings, etc.) shall be of stainless steel, including stainless steel hardware, as indicated in the drawings and shall be approved only after submission of appropriate test data and service histories indicating their acceptability for intended service. In all cases, the specification and requirements

for the fittings supplied shall comply with the appropriate sections of AWWA C906 and must be approved by the Engineer. NO size on size wet taps shall be permitted.

C. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.

2.9 SHIPPING, STORAGE & HANDLING

A. All materials shall be properly loaded so that they will not bear on each other, and shall be braced to prevent damage to material during shipping. Pipe shall be stacked on level ground and per the manufacturer's recommendations to prevent pipe from becoming out of round.

B. All loose parts shall be crated or boxed for shipping, appropriately identified and shipped with the associated pipe sections.

C. Contractor shall protect pipeline sections stored at the site from damage, including weather and vandalism.

D. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe OR on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. The Contractor shall abide by the required handling techniques specified by the Supplier.

E. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects

F. All piping products shall be kept free from dirt, grease, all petroleum based products, and other foreign matter.

G. The Contractor shall provide suitable lifting equipment, slings, spreader bars, rigging etc needed to handle the pipe. In no case shall any equipment be used that is not rated to handle the intended loading or conditions of use to which it is subjected. The use of cables and chains is prohibited.

H. The Contractor shall be responsible for the pipe until such time as it is installed and accepted by the Engineer.

I. The Contractor shall remove any temporary attachments to special components for installation by the Supplier for transportation purposes.

2.10 BEDDING AND COVER MATERIALS

A. Pipe bedding Material: As specified in Section 312000 – Earth Moving.

PART 3 - EXECUTION

3.1 INSTALLATION – HDPE PIPING

A. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instructions of the manufacturer, as shown on the Drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.

B. Under no circumstances shall the pipe or accessories be dropped into the trench or forced through a directional bore upon "pull-back".

C. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches. Sections of pipe with cuts, scratches or gouges exceeding 5 percent of the pipe wall thickness shall be removed completely and the ends of the pipeline rejoined. Repair of damaged pipe during or after installation shall conform to the fabricator's repair procedures or by an Engineer approved repair method.

D. When laying pipe is not in progress, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means.

E. The interior of the pipe shall be cleaned of any foreign matter before being lowered in the trench and kept clean during placement, joint welding, bedding and backfilling operations by plugging or other approved method. Groundwater shall not be permitted to enter the pipe. The full length of each pipe section and each bend shall rest solidly on the compacted bedding material.

F. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

G. If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

H. Contractor shall install HDPE pipe when the ambient air temperature conforms to manufacturer's specifications. The Contractor will be responsible for verifying the temperature by maintaining a log listing dates, times, length of pipe installed and ambient temperature during installation.

I. Trench bottoms shall be graded such that each section of pipe shall be placed to the specified depth or elevation with uniform support. When the bottom of the trench has been excavated below the specified depth or elevation it shall be brought to the specified depth or elevation by backfilling with approved pipe zone material. When material at the bottom of the trench is determined to be unsuitable by the Engineer, it shall be removed and the trench backfilled with approved subgrade material or bedding material to the specified depth of excavation.

J. During pipe installation, the trench bottom shall be kept free of frost, frozen earth, or standing water. The Contractor shall maintain the trench in good, stable condition at all times to prevent caving.

K. Precautions shall be taken to prevent flotation of the pipe in the trench.

L. The pipeline may be buried as it is installed, provided all inspection, testing and backfill requirements are met.

M. All areas disturbed by installation of the pipeline shall be restored in accordance with the specification and drawings.

3.2 JOINING METHOD

A. HDPE pipe shall be joined with butt, heat fusion joints as outlined in ASTM D3261 and conform to the Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe, Technical Report TR-33, published by the Plastic Pipe Institute (PPI). All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the Inspector. The Contractor shall install the HDPE pipeline complete, including bends, couplings, valves, and other associated fittings and appurtenances as shown on the drawings or specified herein and make all necessary connections to the lines and grades shown on the Drawings and in accordance with these specifications.

B. The Contractor shall furnish all welding equipment and all construction materials and equipment required for lugs, railings, templates, spiders or other supports and internal bracing as may be required to hold the components firmly within the specified tolerances during welding, concrete placement or backfill placement. The contractor shall also furnish and install all necessary positioning devices, ties, pedestals and supports required for installation. Details of such equipment shall be included in the proposed installation procedure to be submitted to the engineer prior to the start of work.

C. Lengths of pipe shall be assembled into suitable installation lengths by the butt-fusion process. All pipes so joined shall be made from the same class and type of raw material made by the same raw material supplier. Pipe shall be furnished in standard laying lengths not to exceed 50 feet and no shorter than 20 feet. Installation shall be in accordance with the requirements of AWWA C906 unless otherwise noted, and the Manufacturer's instructions. Contractor shall be responsible for correct fitting of all pipeline members and components.

D. The polyethylene flange adapters shall be used at pipe material transitions and other locations as indicated in the drawings. The adapters shall be connected together or to other flanges by using a stainless steel "back-up" ring conforming to ANSI B16.1 and shaped as necessary to suit the outside dimensions of the pipe. Ensure that back up rings are in place prior to joining flange adapter to piping or other components. The flange adapter assemblies shall be connected with corrosion resistant bolts and nuts of Type 316 Stainless Steel as specified in ASTM A726 and ASTM A307. All bolts shall be tightened to the manufacturer's specified torques. Bolts shall be tightened alternatively and evenly. After installation apply a non-oxide grease coating to bolts and nuts.

E. Where indicated, sleeve couplings shall be used to make HDPE joints. When sleeve couplings are used, stainless steel (Type 316), pipe stiffeners shall be inserted inside of each HDPE pipe end as recommended by the manufacture to prevent the pipe from going out of round and to ensure a leak free joint. Sleeve couplings shall be specifically rated for service with HDPE pipe and shall be as specified in the Contract Documents. Sleeve coupling shall only be used where indicated in the plans and in conjunction with an HDPE Pipe Anchor Block.

3.3 PREPARATION

A. Butt-fusion welded joints: Refer to Manufacturers recommended procedures. All joints formed by butt fusion processes shall be completed in strict accordance with the Manufacturers specified procedures, except where specifically called out in the specifications or drawings. Minimum requirements for butt-fusion welded joints are as follows:
   1. Pipe ends shall be made clean and square prior to fitting and alignment
   2. Care shall be taken to assure a clean work area, free from airborne dust, moisture, or other foreign matter which may contaminate the finished weld.
   3. All internal surfaces of the pipe shall be maintained clean following completion of a weld and prior to starting the next joint.
   4. All butt-fusion joints shall be water tight under the maximum internal pressure.

3.4 BACKFILL PLACEMENT

A. Pipe zone material shall be placed in accordance with Section 312000 – Earth Moving. Care shall be taken to ensure that the material is carefully worked and compacted into the area beneath and around the pipe to provide continuous support to the pipe. Material shall be properly haunched to provide support. Care shall be taken to avoid movement of the pipe during placement and compaction of the bedding material. Pipe bedding shall be placed to the limits shown on the drawings.

B. Trench backfill shall be placed in accordance with section 312000 – Earth Moving.

C. No construction vehicles or ride-on mechanical compaction equipment shall be permitted to travel over the pipe until a minimum of 2 feet of trench backfill is placed above the top of the pipe.

3.5 CONNECTION TO EXISTING

A. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consists of the following:
   1. A polyethylene flange adapter shall be thermally butt-fused to the stub end of the pipe.
   2. A Type 316 stainless steel back up ring shall mate with the polyethylene flange adapter.
   3. Type 316 stainless steel bolts and nuts shall be used to complete the connection.
   4. Flange connections shall be provided with a full-face neoprene gasket.

B. All transitions from HDPE pipe to ductile iron or PVC shall be made per the approval of Engineer and per the HDPE pipe manufacturer's recommendations and specifications. A molded flange connector adapter with a back-up ring assembly shall be used for pipe type transitions. Ductile iron back-up rings shall mate with cast iron flanges per ANSI B16.1. A type 316 stainless steel back-up ring shall mate with a type 316 stainless steel flange per ANSI B16.1 and shall be used in all buried applications.
   1. Transition from HDPE to ductile iron fittings and valves shall be approved by Engineer before installation.
   2. No solid sleeves couplings shall be allowed between such material transitions.
   3. The pipe supplier must certify compliance with the above requirements

C. Prior to making connections to any existing structure or pipe, ensure that new pipe has had the time required to acclimate to the buried conditions. Make the appropriate adjustments required by the

thermal expansion and contraction properties of HDPE materials before connecting to any dissimilar material or structure.

3.6 FIELD QUALITY CONTROL

A. On days butt fusions are to be made, the first fusion shall be a trial fusion in the presence of the Inspector. The following shall apply:

1. Heating plates shall be inspected for cuts and scrapes. The plate temperature shall be measured at various locations to ensure proper heating/melting per manufacturer's recommendations and as approved by the Inspector.
2. The fusion or test section shall be cut out after cooling completely for inspection.
3. The test section shall be 12" or 30 times (minimum) the wall thickness in length and 1" or 1.5 times the wall thickness in width (minimum).
4. The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (i.e. – joint shall have visible molded material between walls of (pipe). Joint spacing between the walls of the two ends shall be a minimum of 1/16" to a maximum 3/16".

3.7 TOLERANCES

A. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-in per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed. Good alignment shall be preserved during installation. Deflection of the pipe shall occur only at those places on design drawings and as approved by the Engineer. Fittings, in addition to those shown on the Drawings, shall be used only if necessary or required by the Engineer.

3.8 CLEANING

A. Do not allow dirt, grease, mud, groundwater, tools, equipment and all other foreign matter to enter the pipe at any point during construction.

B. All pipes shall be completely flushed at a rate with water velocities no less than 4.0 feet per second for pipes up to 12 inches in diameter and 3.0 feet per second for all other pipes. For large diameter pipes, alternate methods, including pigging, of cleaning the pipe may be proposed by the Contractor, subject to the approval of the Engineer, provided proposed method will provide a clean pipe equivalent to flushing as determined by the Engineer.

C. No debris, rubbish, dirt, rocks, or other foreign material shall be permitted to enter downstream sections of the pipeline or system.

D. Furnish, install and permanently remove all cross-connections, piping, valving, ports, etc required to complete the cleaning process. Obtain approval of the Engineer prior to adding any components to the pipeline.

3.9 HYDROSTATIC PRESSURE TESTING

A. Hydrostatic pressure testing shall be conducted per the requirements of ASTM F 2164 and these specifications.

B. All HDPE mains shall be field-tested. Contractor shall supply all labor, equipment, material, gages, pumps, plugs, meters and incidentals required for testing. Each main shall be pressure tested upon completion of the pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.

C. Submit a plan for testing, including schedule, method for water conveyance, control, and disposal, to the Engineer for review at least 10 days before starting the test and notify the Engineer a minimum of 48 hours prior to test

D. The maximum test pressure shall be as indicated in the Drawings but shall not exceed 150 percent of the maximum working pressure of the pipe or the design pressure of any component on the pipe, whichever is less.

E. The test temperature of the piping and the test liquid (water) shall not exceed 73 degrees F. or the temperature related to the pressure rating of the pipe as reported by the manufacturer.

F. Test equipment, preparations and procedures shall implicitly follow the requirements of ASTM F 2164 and the Manufacturer's recommendations.

G. In preparing for test, fill line slowly with water. Maintain flow velocity less than 2 feet per second or less than the capacity of any air release devices use to expel trapped air, whichever is less.

H. Expel air completely from the line during filling and again before applying test pressure. Air shall be expelled by means of taps at points of highest elevation. Any taps installed solely for the purpose of releasing trapped air shall be permanently capped at the conclusion of the test.

I. Once all air is expelled and all testing equipment and pipeline components are adequately braced, gradually increase the pressure in the pipeline to the required maximum test pressure. Hold test pressure for four hours adding make-up water as required to maintain the noted maximum test pressure.

J. After the four hour equalization period, reduce pressure in the pipeline by 10 psi to the test pressure and monitor the pressure for 1 hour. Do not increase the pressure or add make-up water during this time.

K. During and after the one-hour test period, observe all components, joints, fittings, and appurtenances of the pipeline for visible signs of leakage. Any visible signs of leakage indicate a failed test, all such leaks shall be repaired and pipeline retested before pipeline will be accepted. If any visible signs of leakage in any butt-fusion joints in the pipe are noted, immediately stop the test and carefully release the test pressure. Repair the noted leaks and restart test procedure from beginning.

L. A successful hydrostatic pressure test will be indicated by no visible signs of leakage and a steady pipeline pressure within 5 psi of the test pressure throughout the one hour test period without increasing the pressure or the addition of make-up water.

M. Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the Engineer at the point where the pressure is being monitored and shall show on the recorded pressure read-out submitted to the Engineer.

N. Repair and/or replace any failed pipeline sections, components, fittings, valves or other appurtenances to the satisfaction of the Engineer and at no additional expense to the Owner.

3.10 LOW PRESSURE AIR TESTING

A. HDPE pipelines intended for use as air ducts shall be tested for leakage prior to placing the pipe in service. Air test shall not be used for acceptance of any HDPE pipeline except those indicated herein or in the Drawings. Furnish, install and completely remove all fittings, branches, plugs, valves and other appurtenances required to complete the testing process.

B. Prior to beginning air test, HDPE pipeline shall be isolated from pipeline components not rated for the air pressures called for in the test.

C. Low pressure air testing shall be completed per the requirements of ASTM F1417 as given in Section 221066 – Pipeline Testing.

D. Pipeline shall be inspected for all visible infiltration leaks as evidenced by infiltrating groundwater. Leaks shall be located and repaired at no additional cost to the Owner and to the satisfaction of the Engineer.

3.11 MANDREL TESTING

A. After successful completion of hydrostatic test, mandrel test all buried HDPE piping.

B. Mandrel configuration: Rigid with circular cross-section with a diameter of not less than 95% of the average inside diameter of the pipeline with a length of circular proportion equal to the nominal diameter of the pipeline.

C. Mandrel pulling method shall be by hand, rope or as directed by the Engineer.

END OF SECTION 400533

SECTION 400534 – FIBERGLASS REINFORCED POLYMER MORTAR PRESSURE SEWER PIPE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fiberglass reinforced polymer mortar (FRPM) pipe and fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):

a. D638, Standard Test Method for Tensile Properties of Plastics.
b. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
c. D3574, Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
d. D3681, Standard Test Method for Chemical Resistance of "Fiberglass" (Glass Fiber-Reinforced Thermosetting-Resin) Pipe in a Deflected Condition.
e. D4161, Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
f. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

a.
b.

2. American Water Works Association (AWWA):

1.3 AWWA C950 Specifications for Fiberglass Pressure Pipe
AWWA M45 Fiberglass Design Manual

SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 15060.
3. Contractor shall submit the following supplemental requirements as applicable. Design calculations shall be submitted to the Engineer for review prior to manufacture of pipe and fittings.

Product data, including details and size, thickness, length of pipe, fittings with angles, flanges, elbows, reducers, tees, wyes, laterals and other fittings, and joints.
Material properties and strength of pipe and gaskets.
Manufacturer's certification that the proposed piping system is appropriate for the intended service.

a. Manufacturer's written instructions for handling, transporting, storage, and installation of pipe.

b. Test Reports: Submit reports from tests in accordance with ASTM D2412.

c. Shop drawings of all tee-bases and fittings.

d. Product data verifying suitability of pipe and joint materials for use in conditions with soil and ground water contamination that exist at the site which the detailed composition of contaminants are provided with the bid documents.

e. The Contractor shall submit to the Engineer the pipe and fitting warranty provisions, an affidavit from the manufacturer that the pipe, specials, fittings, and other products of material furnished under this Contract is in compliance with all the applicable provisions of ASTM D3754 standards and this specification.

f. The Manufacturer shall have ISO 9001 and ISO 14001 certificate of compliance issued by a third-party independent auditor that all the ASTM D3754 requirements have been met by the production plant where the proposed pipe will be manufactured.

g. The manufacturer shall submit a list 10 projects with 2,000 LF each with 42” and larger pipes supplied and installed project in the United States from the production site where the proposed pipe will be manufactured. The reference list shall contain current contacts (Name, Phone, Email) for each owner, consulting engineer and contractor.

h. Manufacturer’s certified affidavit that it currently has tooling, production capability and capacity to manufacture 18” and 126” pipes without delay.

1.4 WARRANTY

A. Pipe and fitting suppliers shall provide a one-year warranty covering defects in product material and workmanship. A successful pressure test or pressure leak test prior to the expiration of the warranty period shall not relieve the supplier of warranty responsibility for the full warranty term.

1.5 DELIVERY, STORAGE, AND HANDLING

A. All piping shall be bundled or packaged for transportation by commercial carrier to the site.

B. Before off-loading, pipe shall be inspected for damage. Any pipe damaged in shipment shall be assessed and either accepted or rejected as directed by the Engineer, and the pipe supplier shall be notified of rejected pipe within 7 days of delivery at the site. Rejected pipe shall be quarantined for disposition. Each pipe shipment shall be checked for quantity and proper pipe size, color and type.

C. Pipe shall be off-loaded and handled in accordance with the pipe manufacturer’s instructions.

D. Handling and Storage: All pipe handling and storage shall be strictly in accordance with the pipe manufacturer's recommendations.

PRODUCTS

ACCEPTABLE MANUFACTURERS

PART 2

2.1 A. The proposed pipe plant shall have a minimum 25-year continuous history of manufacturing large diameter FRPM pipes as shown on the plans.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. HOBAS Pipe (USA) – Houston, Texas
2. or approved equal.

MATERIALS

2.2 A. Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.

B. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass or Ecr-glass filaments with binder and sizing compatible with impregnating resins.

C. Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.

D. Additives: Curing agents, pigments, dyes, fillers, thixotropic agents, and other resin additives such as micron scale powdered calcium carbonate shall not detrimentally affect the performance of the product.

E. Elastomeric Gaskets: Gaskets shall meet ASTM F477 and be supplied by qualified gasket manufacturers with 10 years of EPDM gasket compounding history and be suitable for the service intended.

2.3 F. The manufacturer of pipe materials must demonstrate a 20-year history of successful installations with over 12 million lineal feet in the United States for sanitary sewer service from the proposed production facility.

PRODUCTS

A. Pipe

1. Pipes: All pipes shall be designed and furnished under the requirements of ASTM D3754 or AWWA C950 by centrifugally casting (CCFRPM) or TopFibra Enhanced Filament Winding (EFW) process and using premium composite components resulting in a dense, nonporous, corrosion-resistant, consistent composite sandwich structure. The interior surface of the pipes (liner) shall be manufactured using a nominal 40-mil (0.040”)

premium made flexible polyester resin with a 25-50% elongation when tested in accordance with ASTM D638 and capable of handling flow velocities of 18 ft./sec for flow without solids present. The interior surface shall provide corrosion, crack and abrasion resistance membrane. The exterior surface of the pipes shall be comprised of 10-mil (0.010") compressed smooth sand and or resin-glass layer which provides short-term UV, impact, and abrasion protection to the exterior. The exterior layer thickness is not to be used for calculations towards pipe strength and pipe stiffness.

2. Inside Diameter: See Drawings. The nominal ID and tolerances for open-cut pipes shall be per dimensions as published in Table 1 of ASTM D3754 in US customary units.
3. Nominal Pressure Class (PN): 150-500 psi
4. Maximum Test Pressure (Tp): 1.5 X PN
5. Maximum Surge Pressure (Ts): 1.4 X PN
6. Nominal Stiffness (SN): 46 to 72 psi.
7. The pipe and fittings shall be free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe and fittings shall also be as uniform as commercially practical in color opacity, density and other physical properties.
8. The Pipe Manufacturer shall provide written confirmation to the Engineer that the pipe and fittings supplied under the terms of this specification meet or exceed these specifications herein.

B. Joints

1. Unless otherwise specified, the coupling shall be a structural filament wound coupling (FWC) or U-Reka sleeve with machined grooves to house EPDM gasket. The joints must meet the pressure performance requirements of ASTM D4161. The coupling shall have the same corrosion rating as the FRPM pipe or higher.
2. Fittings, Flanges, elbows, reducers, tees, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of FRP or steel pipe.
3. Lengths: Pipe shall be supplied in nominal lengths of 20, 40 & 48 feet. Actual laying length shall be nominal ± 2 inches. At least 90% of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.
4. Inside Diameter: See Drawings
5. Stiffness: Joints to match the appropriate pipe stiffness, which varies in accordance with the construction plans.
6. Roundness: Pipe shall be round within 0.2% of the outside diameter.

2.4

7. Wall Thickness: The minimum wall thickness shall be the stated design thickness.
8. End Squareness: Pipe ends shall be square to the pipe axis within ±1/8".

SOURCE QUALITY CONTROL

A. The Contractor shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture as required under this Section.

B. All pipe shall be subject to inspection at the place of manufacture. The Contractor shall notify the Engineer in writing of the manufacturing start date not less than 14 days prior to start of manufacture.

C. Testing: Manufacturer shall furnish results from qualification tests performed by QA/QC staff with a minimum of 10 years of direct fiberglass pipe experience of the following:

1. Pipes shall be manufactured and tested in accordance with ASTM D3574 and other applicable standard.
2. Joints shall meet the requirements of ASTM D4161.
3. Minimum pipe stiffness when tested in accordance with ASTM D2412 shall normally be 36 psi. The inner liner and outer UV shell thickness are excluded from stiffness as required by AWWA M45 load calculation parameters.
4. Pressure Class (PN): 25 psi.

EXECUTION

PART 3 INSTALLATION

3.1 A. Installation of the pipe and fittings shall be in accordance with the drawings and specifications, and pipe manufacturer recommendations.

B. For pipe handling, use textile slings, forklift, or other suitable materials as approved by the Engineer. The use of chains or cables is prohibited.

C. Jointing:

1. Clean ends of pipe and joint components.
2. Apply joint lubricant to pipe ends and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer.
3. Use suitable equipment and end protection to push or pull the pipes together.
4. Do not exceed forces recommended by the manufacturer for joining or pushing pipe.
5. Join pipes in straight alignment then deflect to required angle. Do not allow the deflection angle to exceed 75% of the manufacturer’s recommended deflection.
6. Provide dewatering system to draw down groundwater level below bottom of the pipe trench. See Section 205.
7. Any pipe damage during handling and storage or by transport shall be repaired according to the manufacturer's recommendation or removed from the site and replaced at the Engineer's option, at no additional cost to the Owner. The Engineer's decision regarding rejection shall be final. Rejected pipe shall be clearly and indelibly marked to prevent confusion with pipe in subsequent shipments.
8. If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean

until they are used in the Work. In certain cases, the repair of pipes is allowed onsite under the supervision of a factory trained technician.

9. Precautions shall be taken to prevent floatation of the pipe in the trench. Remove and relay any pipe which has floated. Contractor is responsible to prevent the floatation of the pipe during construction. The contractor to submit installation plan to Engineer for review prior to commencement of construction.
10. Contractor to concrete encase the pipe and fittings as shown on the Plans.
11. All areas disturbed by installation of the pipeline shall be restored in accordance with the specification and drawings.
12. Pipe system shall be field-trim capable without the use of special pipe make up joints. No specially made make-up joints are allowed.

PIPELINE TESTING

3.2 A. Pipeline testing shall be conducted per pipe manufacturer's recommendations. All pipe joints shall be tested per ASTM D35173754.

B. Low Pressure Air Test: Each joint shall be tested with air pressure to no more than 1.5 X PN class using an approved wheel type joint tester.

C. Leak Testing: Installed pipe shall be examined for leaks by exfiltration where the groundwater is below the top of pipe or by infiltration where the groundwater is above the top of pipe.

D. Infiltration Testing: The groundwater table around the pipe must be at least 1 foot above the highest elevation of the top of pipe for the section being examined. The joints may be examined visually for leaks. No leaks should be observed. If a leak is observed, it will be necessary to lower the water table below the area of the leak, and to completely dry and clean the area prior to undertaking a repair weld.

E. Exfiltration Testing: The groundwater table around the pipe must be less than 1 foot above the highest elevation of the top of pipe of the section being examined.

F. Pipe Deflection: After completion of backfilling, removal of stulls, and before acceptance of the Work, all pipes shall be tested for excessive deflection by pulling a mandrel through the pipe, or by other methods acceptable to the Engineer. Pipe with diametrical deflection exceeding five percent (5%) of the nominal inside diameter shall be uncovered and the bedding and backfill replaced as required to prevent excessive deflection. After replacing bedding and backfill, the pipe shall be retested.

3.3 G. Contractor shall at his own expense locate and repair the cause of leakage and retest the line, and all leakage shall be repaired.

FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 15060.

B. Interior of pipeline shall be kept clean and dry during construction. If dirt or debris enters the pipe, the interior of the pipe shall be cleaned by mechanical means.

C. Hydrostatic Tests: Pipe may be tested in accordance with the requirements as recommended by pipe manufacturer to insure zero leakage.

D. Allowable Leakage: No leakage allowed.

E. A pipe manufacturer representative shall be present at the beginning of the pipe installation and shall verify, in writing, that proper procedures are being used by the Contractor to install the pipes.

END OF SECTION 15076

SECTION 400534 – RUBBER HOSE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Hose.

1.2 SUBMITTALS:

A. Product Data: Manufacturer's data indicating service types, sizes, materials, and required accessories.

PART 2 – PRODUCTS

2.1 HOSE

A. Hose material: Neoprene or acceptable oil resistant material suitable for working pressure of minimum 150 pounds per square inch (psi), gauge. Verify existing plant utility water system pressure and provide hose adequate to handle existing pressure if greater than 150 psi, gauge.
B. Size as indicated in the Drawings. Fit ends with appropriate combination clamped nipples and threaded ends as indicated on the Drawings.
C. Hose larger than 1.5 inches in size: Industrial fire hose. Provide one 50-foot long hose for each utility station (hose bib and hose rack) provided.
    a. Manufacturers: One of the following or equal:
        i. Goodyear Rubber Products Corp.
        ii. Uniroyal, Inc.
D. Hose ½ inch through 1.5 inch nominal diameter: General purpose hose. Provide one 75-foot long hose for each utility station (hose bib and hose rack) provided.
    a. Manufacturers:
        i. Goodyear Rubber Products Corp.
        ii. Uniroyal, Inc.

E. Equip and fit hose ends with appropriate combination clamped nipples and threaded ends to make up the assembly indicated on the Drawings.

PART 3 – EXECUTION

3.1 INSTALLATION:

A. Install hose in accordance with manufacturer's instructions.

END OF SECTION 400534

SECTION 400557 – ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the Contractor shall be responsible to the Owner for compliance of the valves, gates, and actuators with the Contract Documents.

D. Single Manufacturer: Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Section 260000 - Electrical General Provisions apply to the Work of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013300 – Contractor Submittals.

B. Shop Drawings: Shop Drawing information for actuators shall be submitted together with the valve and gate submittals as a complete package.

C. Calculations: Selection calculations showing dynamic seating and unseating torques versus output torque of actuator.

D. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, butterfly valve manual actuators, and butterfly valve electric motor actuators under one cover and in accordance with the requirements of Section 013300 – Contractor Submittals.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, shut-off and throttling valves and externally actuated valves and gates shall be provided with manual or power actuators. The Contractor shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall have the torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. Actuator torque ratings for butterfly valves shall be determined in

accordance with AWWA C504 - Rubber-Seated Butterfly Valves. Wires of motor-driven actuators shall be identified by unique numbers.

B. Manufacturers: Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are furnished by different manufacturers, the Contractor shall coordinate selection to have the fewest number of manufacturers possible.

C. Materials: Actuators shall be current models of the best commercial quality materials and be liberally-sized for the required torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.

D. Actuator Mounting and Position Indicators: Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48- and 60-inches above the floor or the permanent working platform.

E. Standard: Unless otherwise indicated and where applicable, actuators shall be in accordance with AWWA C 540 - Power-Actuating Devices for Valves and Slide Gates.

F. Functionality: Electric, pneumatic, and hydraulic actuators shall be coordinated with the power requirements of Division 26.

G. Fasteners: Fasteners shall be in accordance with Section 055000 – Metal Fabrications.

H. Protective Coatings: Protective coatings shall be in accordance with Section 098000 – Protective Coatings.

2.2 MANUAL ACTUATORS

A. General: Unless otherwise indicated, valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4-inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. Buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psi, valves 30-inches in diameter and larger, and where so indicated, shall have worm gear actuators, hermetically-sealed water-tight and grease-packed. Other valves 6-inches to 24-inches in diameter may have traveling nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves: Unless otherwise indicated, buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as required by the local Utility Company or the Engineer. Wrench nuts shall comply with AWWA C 500 - Metal - Seated Gate Valves for Water Supply Service.

C. Chain Actuator: Manually-activated valves with the stem located more than 7-feet above the floor or operating level shall be provided with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains provided by the valve manufacturer. The wheel and guide shall be of ductile iron, cast iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 5-feet 6-inches above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.

D. Floor Stands: Valve actuator floor stands shall be cast iron or fabricated steel pedestals. The centerline of the actuator shall be approximately 42 to 48 inches above the base of the pedestal.

E. Floor Boxes: Hot dip galvanized cast iron or steel floor boxes and covers to fit the slab thickness shall be provided for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

F. Tee Wrenches: Buried valves with floor boxes shall be furnished with 2 operating keys or 1 key per 10 valves, whichever is greater. Tee wrenches sized so that the tee handle will be 2 to 4 feet above ground, shall fit the operating nuts.

G. Manual Worm Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90 degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears or worm gearing. The gear ratio shall be self-locking to prevent "back-driving." The spur or helical gears shall be of hardened alloy steel and the worm gear shall be alloy bronze. The worm gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. Gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Output shaft end shall be provided with spline to allow adjustable alignment. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. Gearing shall be designed for a 100 percent overload. The entire gear assembly shall be sealed weatherproof. Manual worm gear actuators shall be Auma GS Series, Limitorque HBC Series, no “Or-Equals”**.**

H. Traveling-Nut Actuator: The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weatherproof cast iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of nipples. Gearing shall be designed for a 100 percent overload.

I. Schedule for Manual Actuator Types: For a complete schedule of manual actuators required on project valves (4” diameter and larger), see Valve Schedule Drawings.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adapter piece.

2. Gearing: The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm gearing. The spur or helical gears shall be of hardened alloy steel, and the worm gear shall be alloy bronze. Gearing shall be accurately cut with hobbing machines. Power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.
3. Starting Device: Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.
4. Switches
    a. Electronic Type Switches: Limit switches or valve position shall be sensed by a 15 bit, optical, absolute position encoder. The open and closed positions shall be stored in a permanent, non-volatile memory. The encoder shall measure valve position continuously, including both motor and hand wheel operation, with or without use of battery. An electronic torque sensor shall be furnished. The torque limit may be adjusted from 40 to 100 percent of rating in 1 percent increments. The motor shall be de-energized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating, and a "jammed valve" protection feature with automatic retry sequence shall be incorporated to de-energize the motor if no movement occurs. Valve actuators with electronic type switches shall be as manufactured by Limitorque or Auma Actuators, Inc.
    b. The actuator shall be wired in accordance with the schematic diagram. Wiring for external connections shall be connected to marked terminals. One of 1-inch and one of 1.25-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Switches shall not be subject to breakage or slippages due to over-travel. Traveling-nuts, cams, or micro switch tripping mechanisms shall not be used. Limit switches shall be of the heavy-duty open contact type with rotary wiping action.
5. Handwheel Operation: A permanently attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb.ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel. A clutch lever shall be provided to put actuator into handwheel operation. Valves with electric motor actuators having stems more than 7-feet above the floor shall be provided with chain activator handwheels. The clutch lever shall be provided with a cable secured to the chain to allow disengagement for manual operation.
6. Motor: The motor shall be of the totally enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 480 volt, 3-phase 60 Hz current, and have Class F insulation and a motor frame with dimensions in accordance with the latest revised NEMA MG Standards. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor

shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. Bearings shall be of the ball type, and thrust bearings shall be provided where necessary. Bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. Two Class B thermal contacts or solid state thermistors imbedded within the motor windings shall be provided to protect against over-temperature damage. The motor shall be provided with a space heater suitable for operation on 120 volt, single phase, 60 Hz circuit unless the entire actuator is a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion. Each electric motor actuator shall be provided with a local disconnect switch or circuit breaker to isolate power from the motor and controller during maintenance activities.

7. Open/Close Operating Speed: Unless otherwise indicated, electric actuators shall provide a full close to full open or full open to full close operating time range from [30 to 60 seconds].
8. Schedule for Electric AC Actuator Type: For a complete schedule of electric actuators required on project valves (4" diameter and larger), see Mechanical Schedule Drawings.
    a. All electric actuators identified as "OPEN/CLOSE ELECTRIC" in Schedules, shall have AC Reversing type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
    b. All electric actuators identified as "MODULATING ELECTRIC" in Schedules, shall have AC Modulating type actuators with an open to close and close to open speed times of 60 seconds and 60 seconds, respectively.
9. Remote Actuator Control Station. Valves with electric motor actuators where the valve centerline is located at a height greater than 6.5-feet above the floor shall provide a remote actuator control station at a location no higher than 4-feet above the floor. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications. The actuator controls shall be wall-mounted beneath the valve at a location approved by the Design Engineer.

B. Electric Motor Actuators (AC Reversing (Open / Close) Control Type)

1. General: Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with open / stop / close and local/off/remote selector switches on the actuator local control station.
2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at floor elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Starter: The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 480 volt, 3-phase, 60 Hz current. A control power transformer shall be included to provide a 120 volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired as indicated. The integral weatherproof compartment shall contain a suitably sized 120 volt ac, single phase, 60 Hz space heater to prevent moisture condensation on electrical

components. A local power disconnect switch shall be provided with each actuator. A close-coupled, padlockable switch shall be provided with each actuator.

4. Local Control Station: Each actuator shall be provided with a local control station with the valve actuator assembly. The station shall include open, close, and stop push buttons, and a local/remote selector switch.
5. Manufacturers:
    a. Auma, SA Series (for valves 12 inches and smaller) or SA with GS worm gear (for valves 14 inches and larger).
    b. Limitorque, MX/QX Series
    c. Rotork, IQ3 Series
    d. No "Or-Equals" allowed.

C. Electric Motor Actuators (AC Modulating Control Type)

1. General: Where indicated, modulating electric motor actuators shall be the AC modulating type complete with a local control station with power disconnect switch or circuit breaker, provided with open/stop/close and local/off/remote selector switches on the actuator local control station, and open/close status lights.
2. Actuator Appurtenances: The actuator for each valve shall be provided with a padlockable disconnect switch, open and closed status lights, open, close and lockout stop pushbuttons, a local/off/remote selector switch, and other devices indicated. The disconnect switches in certain applications are required to be located remotely from the actuator body itself, as shown on the Contract Drawings. The local control station may also be provided as an integral part of the actuator or remotely as otherwise indicated or required to permit operation by a person at floor elevation and within sight of the valve actuator. The Contractor shall provide conduit and wiring between the actuator controls and the valve actuator for these applications.
3. Control Module: The control module shall be of the electronic solid-state ac type with control outputs for positioning the valve via 4 - 20 ma input signals.
4. Starter: The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes. The solid-state starter and control module shall be rated for continuous modulating applications. Power supply shall be 480 volt, 3 phase, 60 Hz. A disconnect switch shall be included with each actuator.
5. Construction: The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random access memory for storage of calibration parameters and pushbutton calibration elements for field setup. Potentiometer adjustments shall contain a PID control function internally. In addition, the controller shall contain as standard feature a loss of command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4 - 20 ma. As an alternative to the construction requirement, the motor shall be capable of modulating at a rate of 600 starts per hour at the 50 percent to 85 percent travel range of the valve. The system shall allow control of the open, close, or percent open function when the local/off/remote switch is in the remote position. Each actuator shall have a frequency shut down system which when pre-programmed, shall function as directed upon receipt of an ESD signal.
6. Manufacturers:
    a. Auma, SA Series (for valves 12 inches and smaller) or SA with GS worm gear (for valves 14 inches and larger).
    b. Limitorque, MX/QX Series
    c. Rotork IQ3 Series
    d. No "Or-Equals" allowed.

D. 120 VAC Quarter-Turn and Multiturn Electric Valve Operators on Isolation Valves 3-Inch Dia. and Smaller. Where indicated on Contract Drawings, and primarily on vendor supplied equipment skids and control packages, 120 VAC electric actuators may be supplied on smaller valves of 3-inch diameter and smaller, as follows:

1. Provide 120 VAC, 1-phase motor-operated valve operator suitable for use with quarter-turn ball valves, multiturn diaphragm valves, and multiturn globe valves. Operator shall have the following characteristics and features:
   a. Reversing capacitor-start motor rated for operation on 120 V ac, 60 Hz, single phase. Output torque as required for valve application and pressure differential.
   b. Integral motor overload protection, with auto reset
   c. Permanently-lubricated gear train
   d. For open/close control, provide four single pole, double throw cam actuated limit switches (2 OPEN, 2 CLOSED). One set of limit switches shall be used for both motor control and local indication. The other set shall be available for connection to remote monitoring. Limit switch contacts shall be adjustable and shall be rated for not less than 5 amps at 120 V ac.
   e. Local Control Station: Open/Close: Corrosion-resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection and 2 pushbuttons, OPEN and CLOSE. In addition, provide OPEN and CLOSE indicating lights operating at 120 V ac for connection to valve control limit switches.
   f. For modulating control, provide an electronic positioner and feedback potentiometer. The positioner shall utilize a 4 - 20 ma signal to adjust the valve opening. Feedback potentiometer shall be 0 - 1000 ohms.
   g. Local Control Station Modulating: Corrosion resistant, NEMA 4X, for mounting near valve actuator. Provide 2 position selector switch for LOCAL-REMOTE selection, one OPEN and one CLOSE push buttons, a resistance to current converter with 4 - 20 ma output, and a 0 to 100 percent electronic valve position indicator.
   h. Local power disconnect switch (NEMA 4X) for disconnecting 120 V ac power to valve. Disconnect shall be installed in the field within sight of the valve actuator, in accordance with the requirements of NPFA 70.
2. See Drawings for control diagram wiring interface.
3. Two wire control systems are not required for this actuator.
4. Operators shall be RCS, Asahi/America Quarter Master or equal.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments: Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.2 INSTALLATION

A. Valve and gate actuators and accessories shall be installed in accordance with Section 40 05 51 - Valves, General. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways. Actuators shall not be mounted where shock or vibrations will

impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

B. Inspection, Startup, and Field Adjustment: An authorized representative of the manufacturer shall visit the Site and witness the following:
   1. Installation of the equipment for not less than two (2) Work Days
   2. Inspection, checking, and adjusting the equipment for not less two (2) Work Days.
   3. Startup and field-testing for proper operation for not less than two (2) Work Days.

C. Instruction of Owner's Personnel: The authorized service representative shall visit the Site for not less than 2 Days to instruct the Owner's personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment.

END OF SECTION 400557

SECTION 400559–SLIDE AND WEIR GATES

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers Slide and Weir Gates and Operators. The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer.

B. Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation, and shall be the latest standard product of a manufacturer regularly engaged in the production of fabricated gates.

1.2 APPROVED MANUFACTURERS

A. Gates supplied shall be provided by one of the following manufacturers:
   1. Orbinox Gates
   2. Golden Harvest, Inc.
   3. Or equal

1.3 GOVERNING STANDARDS

A. Except as modified or supplemented herein, all gates and operators shall conform to the applicable requirements of AWWA standards.

1.4 QUALITY ASSURANCE

A. The manufacturer shall have 5 years experience in the production of substantially similar equipment, and shall show evidence of satisfactory operation in at least 10 installations. The manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of AWS Sections D1.1, 1.2 and 1.6.

B. The fully assembled gates shall be shop inspected, tested for operation and leakage, and adjusted before shipping. There shall be no assembling or adjusting on the job sites other than for the lifting mechanism.

1.5 SUBMITTALS

A. The manufacturer shall submit for approval by the purchaser, drawings showing the principal dimensions, general construction and materials used in the gate and lift mechanism.

B. The manufacturer shall submit for approval by the purchaser, complete engineering design calculations in compliance with AWWA standards latest edition.

1.6 PERFORMANCE

A. Leakage: Sluice gates shall be substantially watertight under the design head conditions. Under the design seating head, the leakage shall not exceed 0.10 US gallons per minute

per foot of seating perimeter. Under the design unseating head, leakage shall not exceed 0.10 US gallons per minute per foot of perimeter.

PART 2 - PRODUCTS

2.1 GENERAL DESIGN

A. Gates shall be either self-contained or non self-contained of the rising stem or non-rising configuration as indicated on the gate schedule.

B. All parts of the gate shall have a minimum thickness of ¼ inch.

C. Wall thimbles shall be supplied by the gate manufacturer. Refer to the gate schedule for types and applicable locations. Minimum material thickness shall be ¼ inch.

2.2 STAINLESS STEEL SLIDE AND WEIR GATES

A. Frame
1. The gate frame shall be stainless steel and designed for maximum rigidity.
2. The frame configuration shall be of the flush-bottom type and shall allow the replacement of the top and side seals without removing the gate frame from the wall or wall thimble.

B. Slide
1. The slide shall consist of stainless steel plate reinforced to limit its deflection to L/360 of the slide gate's span and L/720 of the weir gate’s span under the design head.

C. Guides and Seals
1. The guides shall be provided with ultra high molecular weight polyethylene seats on both sides of the slide and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position. Guide frame shall not weigh less than 13 lbs. per foot.
2. Side, invert and top seals shall be frame mounted. Seals shall be resilient neoprene J-bulb type with a slotted stainless steel retainer bar. All seals shall be mechanical and fully adjustable in the field.
3. The flush bottom resilient neoprene seal shall be mounted to bottom of disc and seal against the invert portion of the frame. Frame mounted invert seals will not be considered.
4. When required for shutoff purposes, a neoprene top seal shall be mounted to the top spigot member of weir gates.

D. Yoke and Pedestal.
1. The yoke, to support the operating bench stand, shall be formed by two structural members welded at the top of the guides to provide a one piece rigid frame.
2. Self-contained gates shall be provided with a yoke to support the operating bench stand. The yoke shall be formed by two structural members welded at the top of the guides to provide a one piece rigid frame. The maximum deflection of the yoke shall be L/360 of the gate's span.
3. Non-self contained gates shall be provided with pedestal mounted lifts. Pedestal shall be cast iron or mild steel and provided with shop coating

E. Lifting Assemblies

1. Stem and Couplings:
   a. The operating stem shall be of stainless steel designed to transmit in compression at least 2 times the rated output of the operating manual mechanism with a 40 lb effort on the crank or handwheel.
   b. The stem shall have a slenderness ratio (L/R) less than 200. The threaded portion of the stem shall have Acme type cold rolled threads with a maximum surface of 16 micro-inches.
   c. Where a hydraulic, pneumatic or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder with a pressure equal to the maximum working pressure of the supply, or 1.25 times the output thrust of the electric motor in the stalled condition.
   d. Stems in more than one piece shall be joined together by solid couplings.
   e. Gates having a width equal to or greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.
2. Stem Guides: Stem guides shall be fabricated from stainless steel. Stem guides shall be equipped with a UHMWPE bushing. Guides shall be adjustable and spaced in accordance with the manufacturer's recommendation. The L/R ratio shall not be greater than 200.
3. Stem Cover: Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents and a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.
4. Lifting Mechanism
   a. Operators of the types listed in the schedule shall be provided by the gate manufacturer. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lb on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lb.
   b. Gearboxes shall be provided when required to maintain the operating force below 40 lb. All bearings and gears shall be totally enclosed in a weather tight housing. Operator housing shall be cast steel or cast iron. The pinion shaft of crank-operated mechanisms shall be supported by roller bearings. The operating shaft shall be fitted with a 2 inch square operating nut and removable crank. The crank shall be fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 15 inches and the maximum handwheel diameter shall be 24 inches.

F. Materials of Construction

Part	*Material*
Slide, Spigot, Frame, Stiffeners, Yoke, Guide angles.	Stainless Steel Type 304L or 316L ASTM A-276
Side and Top seals	Neoprene ASTM D-2000 or EDPM
Invert seal	Neoprene ASTM D-2000 or EDPM
Bearing bars, Guides, Stem guide liner	Ultra High Molecular Weight Polyethylene ASTM D4020
Bottom seal	Neoprene ASTM D-2000
Threaded stem, Stem guides	Stainless Steel ASTM A-276, Type 304 or 316

Fasteners	Stainless Steel Type 304L or 316
Pedestal	Cast Iron ASTM A126, class B or Mild Steel A36/A36M
Stem cover	Polycarbonate ASTM A-707
Lift and stop nut	Manganeze Bronze ASTM B584, UNS-C86500

2.3 ALUMINUM SLIDE AND WEIR GATES

A. Frame
1. The gate frame shall be extruded aluminum weighing not less then 4-1/4 pounds per foot. The guide grooves in which the head guide angle travel shall contain ultra high molecular weight polyethylene bearing bars in dovetail slots.
2. The frame configuration shall be of the flush-bottom type and shall allow the replacement of the top and side seals without removing the gate frame from the wall or wall thimble.

B. Slide
1. The slide shall consist of aluminum plate reinforced with shaped aluminum extrusion welded to the plate to limit its deflection to 1/720 of the gate's span under the design head.

C. Guides and Seals
1. The guide groves shall contain UHMW bearing bars in dovetail slots and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.
2. Side, invert and top seals shall be field adjustable resilient J-bulb seals attached to the spigot and held in place by a bolted retainer bar. Seals shall be fully adjustable.
3. The flush bottom resilient neoprene seal shall be mounted to bottom of disc and seal against the invert portion of the frame.
4. When required for shutoff purposes, a neoprene top seal shall be mounted to the top spigot member of weir gates.

D. Yoke and Pedestal.
1. Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection of the yoke shall be 1/360 of the gate's span.
2. Non-self contained gates shall be provided with pedestal mounted lifts. Pedestal shall be provided with shop coating.

E. Lifting Assemblies
1. Stem and Couplings:
   a. The operating stem shall be of stainless steel designed to transmit in compression at least 2 times the rated output of the operating manual mechanism with a 40 lb effort on the crank or handwheel.
   b. The stem shall have a slenderness ratio (L/R) less than 200. The threaded portion of the stem shall have Acme type cold rolled threads with a maximum surface of 16 micro-inches.
   c. Where a hydraulic, pneumatic or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder with a pressure equal to the maximum

working pressure of the supply, or 1.25 times the output thrust of the electric motor in the stalled condition.

d. Stems in more than one piece shall be joined together by solid couplings.

e. Gates having a width equal to or greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.

2. Stem Guides

a. Stem guides shall be fabricated from stainless steel. Stem guides shall be equipped with a UHMWPE bushing. Guides shall be adjustable and spaced in accordance with the manufacturer's recommendation. The L/R ratio shall not be greater than 200.

3. Stem Cover

a. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents and a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

4. Lifting Mechanism

a. The operating stem shall be of stainless steel designed to transmit in compression at least 2 times the rated output of the operating manual mechanism with a 40 lb effort on the crank or handwheel.

b. Gates having a width equal to or greater than two times their height shall be provided with two geared lifting mechanisms interconnected by a tandem shaft.

c. The stem shall have a slenderness ratio (L/R) less than 200. The threaded portion of the stem shall have Acme type cold rolled threads with a maximum surface of 16 micro-inches.

d. Stem lengths requiring more than one piece shall be coupled or pinned to an extension tube.

F. Materials of Construction

Part	*Material*
Frame, yoke, slide, stem extension	Aluminum 6061-T-6 ASTM B-209, ASTM B-211
Side and Top seals	Neoprene ASTM D-2000
Bearing bars, Guides, Stem guide liner	Ultra High Molecular Weight Polyethylene ASTM D4020
Bottom seal	Neoprene ASTM D-2000
Threaded stem, Stem guides, Hard crank	Stainless steel ASTM A-276, Type 304 or 304L
Fasteners	Stainless steel Type 304 or 304L
Pedestal / Wall bracket	Cast Iron ASTM A126, class B or Mild Steel A36/A36M
Stem cover	Polycarbonate ASTM A-707
Lift and stop nut	Manganeze bronze , ASTM B584, UNS-C86500

PART 3 - EXECUTION

3.1 EXECUTION

A. Installation: Gates and appurtenances shall be handled and installed in accordance with the manufacturer's recommendations.

B. Field Tests: Following the completion of each gate installation, the gates shall be operated through at least two complete open/close cycles. If an electric or hydraulic operator is used, limit switches shall be adjusted following the manufacturer's instructions. Gates shall be checked for leakage by the contractor.

END OF SECTION 400559

SECTION 400561 –GATE VALVES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve.

B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts list for each type of valve. Include this data, product data, shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.2 QUALITY ASSURANCE

A. Supplier shall have at least ten (10) years' experience in the manufacture of gate valves utilizing elastomer cartridge seats, and shall provide references and a list of installations upon request.

B. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

C. Codes and Standards:
   1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
   2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".

PART 2 - PRODUCTS

2.1 SLURRY KNIFE GATE VALVES

A. Slurry Knife Gate Valves shall be bonnetless, wafer type gate valves made with a cast iron body in sizes 3" through 24" or a fabricated steel body in sizes 30" and up. Port areas shall be 100% of the full pipe area throughout the entire length. The valve will meet MSS SP-81 face-to-face dimensions and ANSI B16.5 Class 150 drilling dimensions. Flush port(s) area will be located in the base of the valve, and will be drilled, tapped, and plugged.

B. All sizes shall have two full-port elastomer cartridge seats halves that shall be supported and compressed between the flanges. The seat halves will be steel reinforced molded rubber and shall act as wiper blades to clean the gate as it strokes. The seats shall provide bi-directional sealing. Elastomer material shall be as specified in the purchase order.

C. Packing box will be of the inverted type, compressed by a weir cast into the valve body. 3 layers of packing material shall be supplied as standard. Packing material shall be as specified in the purchase order.

D. The gate will be of sufficient thickness to provide against permanent deformation at 1.2 times the rated working pressure. The gate shall be ASTM A240 T-316 Stainless Steel. The stem shall be ASTM A276 T-304 Stainless Steel and shall have single pitch acme threads. The stem nut will be acid resistant bronze.

E. Where indicated in drawings, electric actuators shall be provided as specified in Section 400557 of the Specifications.

F. Function:
   1. For manually operated valves: Rotating the handle (and therefore the threaded nut) clockwise pushes the threaded stem towards the valve body, sliding the gate between the rubber seats until the opening is completely blocked. Rotating the handle counter-clockwise pulls the gate out from between the seats, opening the valve.
   2. For electrically actuated valves: An electric motor rotates a threaded nut, pushing the threaded stem towards the valve body, sliding the gate between the rubber seats until the opening is completely blocked. Reversing the direction of the motor pulls the gate out from between the seats, opening the valve.

G. Manufacturer:
   1. Valves shall be provided by one of the following manufacturers:
      a. Orbinox
      b. Or equal

2.2 RESILIENT WEDGE GATE VALVES

A. Resilient wedge gate valves shall meet or exceed all applicable requirements of current revision of ANSI/AWWA C515. They shall be UL listed, FM approved and certified to ANSI/NSF 61 & 372.

B. Valves shall have an AWWA/UL/FM 350 psig working pressure. Each valve shall be factory seat tested to 525 psig and shell tested to 700 psig. The following end types are available: MJ x MJ, FL x FL, FL x MJ, SO x SO, FL x SO.

C. Valve type shall be NRS (non-rising stem).

D. Valves shall have an arrow cast on the operating nut or hand wheel showing opening direction. The direction of opening shall be as specified by owner.

E. Valves shall be provided with a 2” square operating nut. The bolt that attaches the operating nut to the stem shall be recessed into the operating nut so as not to interfere with valve wrench operation. Bolt shall be stainless steel.

F. Valves shall have Type 316 stainless steel bolts and nuts for the stuffing box and bonnet.

G. Valve stems shall have “anti-friction” thrust washers, one above and one below the stem thrust collar to reduce operating torque. Valve stem design shall be such that if excessive input torque is applied, stem failure shall occur above the stuffing box at such a point as to enable the operation of the valve with a pipe wrench or other readily available tool.

H. Valve stems shall be made of bronze ASTM B138 alloy C67600 H04 hard bar stock material. The bronze stem collar is to be hot forge upset; collars not integral with the stem are not acceptable. The stem material shall provide a minimum 73,000 psi tensile strength, yield strength of 48,000 psi

and 8% minimum elongation. Optional bronze stems materials may be ASTM B98 alloy C66100 H02 (half hard).

I. Valves shall have a stuffing box with bolts in line with flow and be O-ring sealed. Stuffing box shall have two integrally cast lifting lugs. Two O-rings shall be placed above and one O-ring below the stem thrust collar. The thrust collar shall be factory lubricated. The thrust collar and its lubrication shall be isolated by the O-rings from the waterway and from outside contamination providing permanent lubrication for long term ease of operation. Valves without a stuffing box are unacceptable. Valves without at least three stem O-rings are also unacceptable.

J. The valve body, bonnet, stuffing box and operating nut shall be composed of ASTM A536 ductile iron. The body and bonnet shall adhere to the minimum wall thickness as set forth in AWWA C515-09 Table 2, section 4.4.1.2. Wall thicknesses that do not meet AWWA minimums are not acceptable.

K. The valve disc and guide lugs shall be composed of ASTM A126 Class B or ASTM A536 ductile iron and fully encapsulated in SBR ASTM D2000 rubber. Guide caps of an acetal bearing material shall be placed over solid guide lugs to prevent abrasion and to reduce the operating torque. Guide lugs placed over bare metal are not acceptable. EPDM ASTM D2000 shall be available as an option.

L. Valves shall have all internal and external ferrous surfaces coated with a fusion bonded thermosetting powder epoxy coating of 10 mils nominal thickness. The coating shall conform to AWWA C550.

M. Tapping valves shall have an inlet flange conforming to ANSI B16.1 Class 125 for attachment to a tapping sleeve or cross. In addition, the valve inlet flange shall have a machined projection or raised alignment lip complying with MSS SP-60 for accurate alignment to the mating recess in the tapping sleeve flange. The seat opening of the tapping valves shall be at least .30” or larger than the nominal pipe size to permit full size shell cutters.

N. Valves shall be warranted by the manufacturer against defects in materials or workmanship for a period of ten (10) years from the date of manufacture. The manufacturing facility for the valves must have current ISO certification.

O. NRS valves shall be MUELLER A2361 series or approved equal. NRS tapping valves shall be Mueller T2361 series or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valve shall be installed in accordance with manufacturer’s written Installation and Operation Manual and approved submittals.

B. Except as otherwise indicated, comply with the following requirements:
1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

C. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

D. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 VALVE INSTALLATION:

A. Locate all valves in locations which will allow easy operation and facilitates maintenance.

B. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

3.4 MANUFACTURER'S CUSTOMER SERVICE

A. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

B. Manufacturer shall also make customer service available directly from the factory in addition to authorized representatives for assistance during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

END OF SECTION

SECTION 400562 - PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide plug valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 400551 - Valves, General apply to this Section.

C. The requirements of Section 400557 - Valve and Gate Actuators apply to this Section.

D. Plug valves shall have undergone a proof-of-design test to demonstrate that the valve components operate at the service flow, pressure, temperature, and fluid conditions, free from binding, excessive noise, and premature failures. Proof-of-design test results shall be available to the Engineer on request. The proof-of-design test shall be conducted in accordance with the applicable provisions of AWWA C517.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 400551.

PART 2 - PRODUCTS

2.1 GENERAL

A. Plug Valves shall be quarter-turn, non-lubricated with resilient encapsulated plug. Valves shall have port areas of not less than 100% of pipe area.

B. Standards, Approvals and Verification:
   1. Valves shall be designed, manufactured and tested in accordance with American Water Works Association Standard ANSI/AWWA C517.
   2. All Plug Valves shall be certified Lead-Free in accordance with NSF/ANSI 372.
   3. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

C. Connections:
   1. Threaded valves shall have threaded NPT full size inlets. The connection shall be hexagonal for a wrench connection.
   2. Flanged valves shall have flanges with drilling to ANSIB16.1, Class 125.
   3. Mechanical Joint valves shall fully comply with ANSI/AWWA C111/A21.11.

D. Manufacture:
   1. Manufacturer shall demonstrate a minimum of ten (10) years' experience in the manufacture of plug valves. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings and operation and maintenance manuals.

2. The exterior of the valve for above ground service shall be coated with a universal alkyd primer. Valve exterior for buried service shall be coated with an epoxy coating.
3. Valve shall be marked with the Serial Number, Manufacturer, Size, Cold Working Pressure (CWP) and the Direct and Reverse Actuator Pressure Ratings on a corrosion resistant nameplate.
4. Acceptable Manufacturers:
    a. Valmatic (Basis of Design)
    b. DeZurik
    c. Or equal

2.2 ECCENTRIC PLUG VALVES (1/2-INCH TO 3-INCHES)

A. Design:
1. Threaded valve seat shall be a machined seating surface.
2. 2 ½ in. valves and larger shall have a valve seat that is a welded overlay of 95% pure nickel applied directly to the body on a pre-machined, cast seating surface and machined to a smooth finish.
3. Threaded valves shall have shaft seals which consist of V-type lip seal in a fixed gland with a resilient O-ring spring.
4. 2 ½ in. valves and larger shall have shaft seals which consist of V-type packing in a fixed gland with an adjustable follower designed to prevent over compression of the packing and to meet design parameter of the packing manufacturer. Removable POP™ shims shall be provided under the follower flanges to provide for adjustment and prevent over tightening.
5. Permanently lubricated, radial shaft bearings shall be supplied in the upper and lower bearing journals. Thrust bearings shall be provided in the upper and lower journal areas, except for threaded type which only have upper thrust bearings.
6. Both the packing and bearings in the upper and lower journals shall be protected by a Grit-Guard™ "drip tight" Buna-N shaft seal located on the valve shaft to minimize the entrance of grit into the bearing journal and shaft seal areas.
7. The threaded valve body shall have 1/8" NPT upstream and downsteam pressure ports.

B. Materials:
1. Valve bodies and covers shall be constructed of ASTM A126 Class B cast iron for working pressures up to 175 psig and ASTM A536 Grade 65-45-12 for working pressures up to 250 psig. The words "SEAT END" shall be cast on the exterior of the body seat end.
2. Threaded valve plugs shall be of one-piece construction and made of ASTM A126 Class B cast iron fully encapsulated with a resilient facing per ASTM D2000-BG and ANSI/AWWA C517 requirements.
3. 2 ½ in. plugs and larger shall be of one-piece construction and made of ASTM A126 Class B cast iron or ASTM A536 Grade 65-45-12 ductile iron and fully encapsulated with resilient facing per ASTM D2000-BG and ANSI/AWWA C517 requirements.
4. Threaded valves shall have radial shaft bearings constructed of self-lubricating Type 316 stainless steel. The top thrust bearing shall be Teflon.
5. 2 ½ in. plug valves and larger shall have radial shaft bearings constructed of self-lubricating Type 316 stainless steel. The top thrust bearing shall be Teflon. The bottom thrust bearing shall be self-lubricating Type 316 stainless steel. Cover bolts shall be corrosion resistant with zinc plating.

C. Actuators:
1. Threaded valves shall be equipped with a hand lever with a dial indicator and open memory stop.

2. Valves 2 ½ in. and larger shall be equipped with a 2-inch square nut for direct quarter turn operation. The packing gland shall include a friction collar and an open position memory stop. The friction collar shall include a nylon sleeve to provide friction without exerting pressure on the valve packing.
3. All gear actuators shall be designed to withstand, without damage, a rim pull of 200 lb. on the hand wheel and an input torque or 300 ft-lbs. for nuts.
4. Buried service actuators shall be packed with grease and sealed for temporary submergence to 20 feet of water. Exposed worm shafts shall be stainless steel.

2.3 ECCENTRIC PLUG VALVES (3-INCHES TO 54-INCHES)

A. Design:
1. Valves shall have a valve seat that is a welded overlay of 95% pure nickel applied directly to the body on a pre-machined, cast seating surface and machined to a smooth finish.
2. Valves shall have shaft seals which consist of V-type packing in a fixed gland with an adjustable follower and removable shims under the follower flange to provide for adjustment and prevent over compression.
3. Permanently lubricated, radial shaft bearings shall be supplied in the upper and lower bearing journals to eliminate the need for grease fittings. Thrust bearings shall be provided in the upper and lower journal areas, except for threaded type which only have upper thrust bearings.
4. Both the packing and bearings in the upper and lower journals shall be protected by Buna-N shaft seals located on the valve shaft to minimize the entrance of grit into the bearing journal and shaft seal areas.

B. Materials:
1. Valve bodies and covers shall be constructed of ASTM A126 Class B for working pressures up to 175 psig. The words “SEAT END” shall be cast on the exterior of the body seat end.
2. Plugs shall be of one-piece construction and made of ASTM A536 Grade 65-45-12 ductile iron and fully encapsulated with resilient facing per ASTM D2000-BG and ANSI/AWWA C517 requirements.
3. Plug valves shall have radial shaft bearings constructed of self-lubricating Type 316 stainless steel. The thrust bearings shall be PTFE. Cover bolts shall be corrosion resistant with zinc plating.

C. Actuation:
1. Valves shall be equipped with a 2 inch square nut for direct quarter turn operation with a hand lever. The packing gland shall include a friction collar and an open position memory stop. The friction collar shall include a nylon sleeve to provide friction without exerting pressure on the valve packing.
2. Valves shall include a totally enclosed and sealed worm gear actuator with position indicator (above ground service only) and externally adjustable open and closed stops. The worm segment gear shall be ASTM A536 Grade 65-45-12 ductile iron with a precision bore and keyway for connection to the valve shaft. Bronze radial bearings shall be provided for the segment gear and worm shaft. Alloy steel roller thrust bearings shall be provided for the hardened worm.
3. All gear actuators shall be designed to withstand, without damage, a rim pull of 200 lb. on the hand wheel and an input torque or 300 ft-lbs. for nuts.
4. Buried service actuators shall be packed with grease and sealed for temporary submergence to 20 feet of water. Exposed worm gear shafts shall be stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Plug valves shall be installed in strict accordance with the manufacturer's published recommendations.

B. Eccentric Plug Valves: Unless otherwise directed, the following rules shall be observed for the installation of eccentric plug valves on sewage, sludge, or other liquid systems containing solids, silt, or fine sand:
   1. The valves shall be positioned with the stem in the horizontal direction.
   2. In horizontal pipelines, the plug shall swing upwards when opening, to permit flushing out of solids.
   3. The orientation of the valve shall prevent the valve body from filling up with solids when closed; however, where the pressure differential through the valve exceeds 25 psi, the higher pressure for valves without worm gear, electric, or air operators shall be through the valve to force the plug against the seat.
   4. Valves which may be closed for extended periods (stand-by, bypass, or drain lines) and valves with reversed flow (higher pressure on downstream side, forcing the plug away from its seat), shall be equipped with worm gear operators for the full range of sizes.
   5. For special applications or when in doubt, consult with the manufacturer prior to installation.

C. Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

D. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

E. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

F. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

G. Locate all valves in locations which will allow easy operation and facilitates maintenance.

H. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 MANUFACTURER'S CUSTOMER SERVICE

A. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

B. Manufacturer shall also make customer service available directly from the factory in addition to authorized representatives for assistance during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

END OF SECTION

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SECTION 400564 - BUTTERFLY VALVES

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 400557 – Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013300.

B. Shop Drawings
   1. Complete Shop Drawings of butterfly valves and actuators.
   2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.
   3. Certification of proof-of-design test from the valve manufacturer.
   4. Certification: The Contractor shall obtain written certification from the butterfly valve manufacturer, addressed to the Owner, stating that the butterfly valves and the valve operators will efficiently and thoroughly perform the required functions in accordance with these Specifications and as shown, and that the manufacturer accepts joint responsibility with the Contractor for coordination of all butterfly valves and valve operators, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed units. The Contractor shall submit all such certificates to the construction manager.
   5. Technical Manuals: The Contractor shall furnish technical manuals for the butterfly valves, manual operators, and electric motor valve operators under one cover and in accordance with the requirements of Section 013300 - Contractor Submittals.
   6. Valve Labeling: The Contractor shall submit a schedule of butterfly valves to be labeled indicating in each case the valve location and the proposed wording for the label.
   7. Field Procedures: Written instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to delivery of the butterfly valves and valve operators.

1.3 QUALITY ASSURANCE

A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

PART 2 - PRODUCTS

2.1 RESILIENT SEATED BUTTERFLY VALVE

A. General
   1. Valves shall conform to ANSI/AWWA C504 and shall be of the size indicated.

2. The manufacturer shall have produced AWWA butterfly valves for a minimum of five years.
3. Acceptable Manufacturers
    a. Bray
    b. Keystone
    c. Or equal

B. Design
1. Body
    a. Shall be one-piece wafer or lug design with extended neck to allow for 2" of piping insulation.
    b. Flange location holes shall be provided on wafer bodies to allow for quick and precise alignment during valve installation.
    c. Flange hole drilling per international flange standard as specified.
    d. A non-corrosive bushing and a self-adjusting stem seal shall be provided. No field adjustment shall be necessary to maintain optimum field performance.
2. Disc
    a. Dis edge and hub on metal discs shall be spherically machine and hand polished for torque and maximum sealing capability.
    b. The disc shall be a lens-shaped design to afford minimal pressure drop and line turbulence.
3. Stem
    a. Shall be one-piece design.
    b. Disc to stem connection shall be an internal double "D" design with no possible leak paths in the disc-to-stem connection. External disc-to-stem connections such as disc screws or pins are not allowed.
    c. Stem shall be mechanically retained in the body neck and no part of the stem shall be exposed to the line media.
4. Seat
    a. Shall be tongue-and-groove seat with a primary hub seal and a molded flange O-ring for weld-neck and slip-on flanges.
    b. The seat shall totally encapsulate the body isolating it from the line media and no flange gaskets shall be required.
    c. Seats may not be located on the disc or be retained by segments and/or screws.
5. Bearings
    a. Valve bearings shall be of a self-lubricating, nonmetallic material to effectively isolate the disc-shaft assembly from the valve body. Metal-to-metal thrust bearings in the flow stream are not allowed.
6. Testing: Valve shall be tested to 110% of the rated pressure.
7. Pressure rating
    a. Valve shall be rated for bubble-tight shut-off at the following pressure rating:
        1) Series 30/31: 150 psi
        2) Series 31H: 250 psi

C. Materials of Construction
1. Body: As noted in valve schedule
2. Disk:
    a. Water and wastewater service: coated ductile iron
    b. RO permeate water: Nylon 11 coated ductile iron
    c. Process air: stainless steel

3. Stem: 316 stainless steel
4. Seat:
    a. Water and wastewater: EPDM
    b. RO permeate water: EPDM
    c. Process Air: EPDM or Viton where specifically noted.

2.2 DOUBLE OFFSET HIGH PERFORMANCE BUTTERFLY VALVE

A. General
1. Valves shall conform to ANSI/AWWA C504 and shall be of the size indicated.
2. The manufacturer shall have produced AWWA butterfly valves for a minimum of five years.
3. Acceptable Manufacturers
    a. Bray
    b. Keystone
    c. Or equal

B. Design
1. Body
    a. Shall be one-piece wafer, lug or double flanged design with extended neck to allow for 2” of piping insulation.
    b. Flange hole drilling per international flange standard as specified.
    c. Provided with top and bottom stem bearings consisting of a 316 stainless steel shell with a TFE/glass fabric liner bearing surface.
    d. Equipped with an externally adjustable stem packing system that allows packing adjustment without removing the actuator.
    e. Internal over-travel stop shall be provided to prevent over-travel of the disc and minimize possible seat damage.
2. Disc
    a. Dis edge and hub on metal discs shall be spherically machine and hand polished for torque and maximum sealing capability.
3. Stem
    a. Shall be one-piece design
    b. Stem shall be provided with blow-out proof stem retention system to assure full retention of the stem in the unlikely event of an internal stem failure.
4. Seat
    a. Design shall consist of a resilient energizer totally encapsulated by the seat.
    b. Seat retainer shall be full-faced and firmly attached by bolts located outside the sealing area to protect them from corrosion.
    c. The seat assembly shall be locked in the body recess by the full-faced retainer.
    d. The seat shall be self-adjusting for wear and temperature changes.
    e. The seat shall be easily field replaceable.
5. Testing: Valve shall be tested for tight shut-off per API 598 requirements.
6. Pressure ratings: Valves shall be rated for a minimum of 285 psi.

C. Materials of Construction
1. Body: Stainless steel
2. Disk: Stainless steel
3. Stem: 316 stainless steel
4. Seat: RTFE

PART 3 - EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with manufacturers recommendation.

B. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

C. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

END OF SECTION

SECTION 400565 - VALVES FOR PUMP CONTROL AND CHECK SERVICE

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve.

B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts list for each type of valve. Include this data, product data, shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.2 QUALITY ASSURANCE

A. Supplier shall have at least ten (10) years' experience in the manufacture of knife gate valves utilizing elastomer cartridge seats, and shall provide references and a list of installations upon request.

B. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

C. Codes and Standards:
   1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
   2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".

PART 2 - PRODUCTS

2.1 SWING CHECK VALVES (2-1/2 INCHES AND SMALLER)

A. General: Swing check valves for steam, water, oil, or gas in sizes 2-1/2 inches and smaller shall be suitable for a steam pressure of 150 psi and a cold water pressure of 300 psi. Units shall have screwed ends unless otherwise indicated, and screwed caps.

B. Body: The valve body and cap shall be of bronze conforming to ASTM B 763 - Copper Alloy Sand Castings for Valve Application, or ASTM B 584 with threaded ends conforming to ASME B1.20.1 - Pipe Threads, General Purpose (inch).

C. Disc: Valves for steam service shall have bronze or brass discs conforming to ASTM B 16 - Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines, and for cold water, oil, and gas service replaceable composition discs.

D. Hinge Pin: The hinge pins shall be of bronze or stainless steel.

E. Manufacturers, or Equal
   1. Crane Company
   2. Milwaukee Valve Company
   3. Stockham Valves and Fittings
   4. Wm. Powell Company

2.2 PLASTIC BALL CHECK VALVES

A. General: Plastic ball check valves for corrosive fluids, in sizes up to 4-inches, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions.

B. Construction: The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections or flanged ends conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. Seals shall have Viton O-rings, and valve design shall minimize possibility of the balls sticking or chattering. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

C. Manufacturers, or Equal
   1. ASAHI-AMERICA
   2. George Fischer, Inc.
   3. NIBCO Inc. (Chemtrol Division)
   4. Spears Mfg. Co. (PVC, CPVC, AND PP only)

2.3 PLASTIC SWING OR WYE-CHECK VALVES

A. General: Plastic swing or wye-check valves for corrosive fluids, in sizes up to 8-inches or as available, may be used for horizontal or vertical up-flow conditions.

B. Construction: The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction as best suited for each individual service condition. They shall have flanged ends conforming to ASME B16.5 Class 150, and flanged top access covers and shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inches and smaller. For larger sizes and other materials and temperatures the pressure rating may be lower.

C. Manufacturers, or Equal
   1. Valmatic (Swing Flex)
   2. ASAHI-AMERICA
   3. George Fischer, Inc.
   4. Spears Mfg. Co. (Plastic Swing Check only)

2.4 SWING – FLEX CHECK VALVES

A. Scope
   1. This section covers the design, manufacture, and testing of 2 in. through 48 in. Swing-Flex Check Valves suitable for cold working pressures up to 250 psig, in water, wastewater, abrasive, and slurry service.
   2. The check valve shall be of the full flow body type, with a domed access cover and only one moving part, the flexible disc.

B. Standards and Approvals

1. The valves shall be designed, manufactured, tested and certified to American Water Works Association Standard ANSI/AWWA C508.
2. The valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components – Health Effects, and certified to be Lead-Free in accordance with NSF/ANSI 372.
3. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

C. Connections

1. The valves shall have flanges with drilling to ANSI B16.1, Class 125.

D. Design

1. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 in. valve shall be capable of passing a 3 in. solid. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator or oil cushion device without special tools or removing the valve from the line.
2. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.
3. The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface and reinforced with alloy steel. The flex portion of the disc contains nylon reinforcement and shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a memory disc return action to provide a cracking pressure of 0.25 psig.
4. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures.

E. Materials

1. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B gray iron for 30 in. (800mm) and larger. Optional body materials include ASTM A-351 Grade CF8M, stainless steel for sizes 3” (80 mm) through 12” (300 mm).
2. The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG. Optional disc material includes Viton, EPDM, Hypalon.

F. Manufacture

1. Manufacturer shall demonstrate a minimum of five (5) years’ experience in the manufacture of resilient, flexible disc check valves with hydraulic cushions.
2. All valves shall be hydrostatically tested and seat tested to demonstrate zero leakage. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
3. The exterior and interior of the valve shall be coated with an NSF/ANSI 61 approved fusion bonded epoxy coating.
4. Swing-Flex® Check Valves shall be Series #500 as manufactured by Val-Matic® Valve & Mfg. Corporation, Elmhurst, IL. USA or equal.

2.5 DUAL DISK CHECK VALVES

A. Scope

1. This specification covers the design, manufacture, and testing of 2 in. through 12 in. dual disc check valves suitable for pressures up to 250 psig water service.
2. The check valve shall be of the dual disc, wafer style with torsion spring induced closure.

B. Standards, approvals and verification

1. The valves shall be designed, manufactured and tested in accordance with American Water Works Association standard ANSI/AWWA C518.
2. The valves for use in fire protection systems shall be Underwriters Laboratories listed and Factory Mutual approved in sizes 2 1/2”-12”.
3. The valves shall be certified to be lead-free in accordance with NSF/ANSI 61, Annex G.
4. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

C. Connections

1. Wafer style valves shall be provided in sizes 2 in through 12 in for installation between ANSI B16.1 Class 125 iron flanges, or between ISO 7005-2 PN10 or PN16 flanges. Grooved end valves shall be provided in 2” through 12” for installation on pipe with cut grooves per ANSI/AWWA C606 for steel IPS pipe.

D. Design

1. The body shall be of one-piece construction incorporating a vulcanized synthetic seal.
2. Seal design shall include a raised sealing bead for positive seating at both high and low pressures. The disc shall fully overlap the synthetic seal, preventing pressure indentations.
3. Opening and closing of the valve shall utilize a lift and pivot action to prevent seal wear and ensure long seal life.
4. Disc stabilization in the full open position shall be provided by the use of a stop pin.
5. The stop and pivot pins shall be stabilized by the use of synthetic spheres to prevent wear due to vibration during operating conditions. The design shall incorporate a raised seat and 1/2” body wall to disc clearance to ensure proper operation after long periods of inactivity and potential corrosion buildup.
6. Cv flow coefficients shall be equal to or greater than specified below and verified by an independent testing laboratory.

Valve Size	Cv	
	Wafer	Grooved
2 in	76	77
2.5 in	161	129
3 in	224	209
4 in	400	358
5 in	648	573
6 in	1060	898
8 in	1890	1740
10 in	3340	3180
12 in	5270	4950

8. Closure shall be assisted with a torsion spring to provide a cracking pressure of 0.25 psig.

E. Materials
1. The valve body shall be constructed of astm a536 grade 65-45-12 ductile iron.
2. The disc shall be constructed of astm b584, alloy c87600 (2”-12”) cast bronze. The pivot pins and stop pins shall be type 316 stainless steel.
3. The torsion spring shall be astm a313 type 316 stainless steel.
4. The seal shall be buna-n per astm d2000-bg.

F. Manufacture
1. The valves shall be hydrostatically tested at 2 times their rated cold working pressure. A seat closure test at 2 times the valve rating shall be conducted to demonstrate zero leakage. Additional tests shall be conducted per awwa, ansi, mss or api standards when specified. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
2. The exterior of the valve shall be coated with a universal alkyd primer.
3. Check valves shall be series #8800w (wafer style) and series #8800g (grooved end) as manufactured by val-matic® valve & mfg. Corporation, elmhurst, il. Usa or approved equal.

2.6 SUCTION LINE FOOT VALVES

A. Scope
1. This section covers the design, manufacture, and testing of 2 in. through 42 in. Sure Seal Foot Valves suitable for pressures up to 200 psig water service.
2. The Foot Valve shall be of the full flow globe style designed to provide silent operation, positive seating, and full flow area.

B. Standards, Approvals and Verification
1. The valves shall be certified to be Lead-Free in accordance with NSF/ANSI 61, Annex G.
2. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

C. Connections
1. The Foot Valves shall be provided with flanges in accordance with ANSI B16.1 for Class 125 iron flanges.

D. Design
1. The valve design shall incorporate a center guided disc, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe size.
2. All component parts shall be field replaceable without the need of special tools. A replaceable guide bushing shall be provided and held in position by threaded bushing retainer.
3. The valve disc shall be concave to the flow direction providing for disc stabilization, maximum strength, and a minimum flow velocity to open the valve.
4. The valve disc and seat shall have a seating surface finish of 32 micro-inch or better to ensure positive seating at all pressures. A Buna-N seal shall be provided on the seat to provide for zero leakage at both high and low pressures without overloading or damaging the seal. The seal design shall provide both a metal to metal and a metal to Buna-N seal.
5. A heavy-duty basket type screen shall be bolted to the inlet flange outside diameter and provide 3-4 times the pipe area.

E. Materials

1. The valve body shall be constructed of ASTM A126 Class B cast iron.
2. The seat and plug shall be ASTM A351 Grade CF8M stainless steel.
3. The basket screen shall be stainless steel, Type 304.

F. Manufacture
1. The valves shall be hydrostatically tested at 1.5 times their rated cold working pressure. Additional tests shall be conducted per AWWA, ANSI, MSS or API standards when specified. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.
2. The exterior of the valve shall be coated with a universal alkyd primer.
3. Foot Valves shall be Series #1900 as manufactured by Val-Matic® Valve & Mfg. Corporation, Elmhurst, IL. USA or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valve shall be installed in accordance with manufacturer's written Installation and Operation Manual and approved submittals.

B. Except as otherwise indicated, comply with the following requirements:
1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

C. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

D. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 VALVE INSTALLATION:

A. Locate all valves in locations which will allow easy operation and facilitates maintenance.

3.4 MANUFACTURER'S CUSTOMER SERVICE

A. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

B. Manufacturer shall also make customer service available directly from the factory in addition to authorized representatives for assistance during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

END OF SECTION

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SECTION 400567 – BALL VALVES

PART 1 - GENERAL

1.1 SCOPE:

A. Furnish and install all valves complete and in accordance to the requirements of the Contract Documents.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve.

B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

C. Maintenance Data: Submit maintenance data and spare parts list for each type of valve. Include this data, product data, shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service.

B. Valve Types: Provide valves of same type by same manufacturer.

C. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

D. Codes and Standards:

1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".
3. U-PVC: Conforming to ASTM D1784 Cell Classification 12454 A
4. CPVC – Conforming to ASTM D1784 Cell Classification 23567 A
5. Polypropylene – Conforming to ASTM D4101 Cell Classification PP0210B67272
6. PVDF – Conforming to ASTM D3222-91A Cell Classification Type II

PART 2 - PRODUCT

2.1 PLASTIC BALL VALVES (1/2" – 6")

A. All valves shall be true-union design with 2-way blocking capability. PTFE seats shall have elastomeric backing cushions to provide smooth even stem torque and to compensate for wear. Valves shall feature molded ISO mounting top flange for actuation installation and Panel Mount feature on bottom of valve for securing in-line. The handle shall double as the spanner wrench for maintenance and carrier adjustment.

B. Valve shall have a pressure rating of 150 psi at 70ºF.

C. Where noted on contract drawings, a 1/8" Vent Hole factory drilled and de-burred by the manufacturer shall be added to eliminate the hazard of pressurization.

D. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering ball valves which may be incorporated in the work are:

1. Asahi America, Inc.
2. George Fischer
3. Dura Plastic Products, Inc.
4. Hayward
5. Or equal.

2.2 STAINLESS STEEL BALL VALVES

A. Features:
1. 316 SS Ball Construction
2. SS Body construction
3. RPTFE seat
4. Threaded
5. Full Port
6. Two piece body design
7. Solid Ball Construction
8. SS Lever and Nut
9. Blow out proof stern design
10. Nylon lever grip
11. 150 psi rated

B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering ball valves which may be incorporated in the work are:
1. Apollo Valves
2. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Except as otherwise indicated, comply with the following requirements:

Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.

Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections.

1. Pipe Size 2" and Smaller: One of the following, at Installer's option:

   a. Threaded valves.
   b. Flanged valves.

2. Pipe Size 2-1/2" and Larger:

   a. Flanged valves.
   b. Grooved joint valves.

D. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 VALVE INSTALLATION:

A. Locate all valves in locations which will allow easy operation and facilitates maintenance.

B. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

END OF SECTION

SECTION 400571 – DUCKBILL CHECK VALVES

PART 1 - GENERAL

2.1 SCOPE:

A. Furnish and install all valves complete and in accordance to the requirements of the Contract Documents.

2.2 SUBMITTALS:

A. Submit product literature that includes information on the performance and operation of the valve, materials of construction, dimensions and weights, elastomer characteristics, flow data, headloss data, and pressure ratings.

B. Upon request, provide shop drawings that clearly identify the valve dimensions.

C. Upon request, manufacturer shall provide installation and reference lists for existing valves of similar size and type to the project scope.

2.3 QUALITY ASSURANCE:

A. Supplier shall have at least fifteen (15) years' experience in the manufacture of "duckbill" style elastomeric valves.

B. Manufacturer shall have conducted independent hydraulic testing to determine headloss and jet velocity characteristics on a minimum of eight sizes of duckbill valves ranging from 2" through 48". The testing must include multiple constructions (stiffness) within each size and must have been conducted for free discharge (discharge to atmosphere) and submerged conditions.

C. Manufacturer shall have conducted an independent hydraulic test where multiple valves (at least four) of the same size and construction (stiffness) were tested to validate the submitted headloss characteristics and to prove the repeatability of the manufacturing process to produce the same hydraulic characteristics.

D. Manufacturer to have conducted Finite Element Analysis (FEA) on various duckbill valves to determine deflection, stress and strain characteristics under various load conditions. Modeling must have been done for flowing conditions (positive differential pressure) and reverse differential pressure.

E. Valves 24" and larger must incorporate a metallic support completely encapsulated in the wall thickness at the top portion of the valve to assist in supporting the weight of the valve.

F. The bill slit of the duckbill valve must be at least 1.57 times the nominal pipe diameter.

PART 2 - PRODUCTS

2.1 "DUCKBILL" ELASTOMERIC CHECK VALVE

A. Check Valves are to be all rubber of the flow operated check type with a slip-on connection. The Check Valve is designed to slip over the specified pipe outside diameter and attached by means of vendor furnished stainless steel clamps. The port area shall contour down to a duckbill, which shall allow passage of flow in one direction while preventing reverse flow. The valve shall be one piece rubber construction with nylon reinforcement. The duckbill shall be offset so that the bottom line of the valve is flat, keeping the invert of the pipe parallel with the invert of the valve. The top of the valve shall rise to form the duckbill shape. The bill portion shall be thinner and more flexible than the valve body and formed into a curve of 180°.

B. Manufacturer must have available flow test data from an accredited hydraulics laboratory to confirm pressure drop data. Company name, plant location, valve size and serial number shall be bonded to the check valve.

2.2 FUNCTION

A. When line pressure inside the valve exceeds the back pressure outside the valve, the line pressure forces the bill of the valve open, allowing flow to pass. When back pressure exceeds the line pressure, the bill of the valve is forced closed. The flat bottom allows the valve to be installed where minimal bottom clearance exists.

2.3 MANUFACTURER

A. All valves shall be of the Series TF-1 as manufactured by Tideflex® Technologies, Carnegie, PA 15106. All valves shall be manufactured in the U.S.A.

B. Or approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valve shall be installed in accordance with manufacturer's written Installation and Operation Manual and approved submittals.

3.2 MANUFACTURER'S CUSTOMER SERVICE

A. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

B. Manufacturer shall also make customer service available directly from the factory in addition to authorized representatives for assistance during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

END OF SECTION 400571

SECTION 400578 – COMBINATION RELIEF VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide plug valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 400557 - Valve and Gate Actuators apply to this Section.

C. Plug valves shall have undergone a proof-of-design test to demonstrate that the valve components operate at the service flow, pressure, temperature, and fluid conditions, free from binding, excessive noise, and premature failures. Proof-of-design test results shall be available to the Engineer on request. The proof-of-design test shall be conducted in accordance with the applicable provisions of AWWA C517.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013300.

PART 2 - PRODUCTS

2.1 GENERAL

A. This specification is intended to cover the design, manufacture, and testing of 1 in. through 8 in. combination air valves suitable for pressures up to 150 psig.

B. Combination air valves shall be automatic float operated valves designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. The valve shall open during draining or if a negative pressure occurs. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure. The valve shall perform the functions of both air release and air/vacuum valves and furnished as a single body or dual body type as indicated on the plans.

2.2 STANDARDS, APPROVALS AND VERIFICATION

A. Valves shall be manufactured and tested in accordance with American Water Works Association (AWWA) Standard C512.

B. Valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components.

C. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

2.3 WASTEWATER COMBINATION VALVES

A. Connections

1. Single body valves sizes 4 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size with a 2 in. inlet on 1 in. valves. The body inlet connections shall be hexagonal for a wrench connection. The body shall have 2" NPT cleanout and 1" NPT drain connection on the side of the casting.
2. Dual body valves sizes 3 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size with a 2 in. inlet on 1 in. valves. The body inlet connection shall be hexagonal for a wrench connection. Valve sizes 4 in. through 6 in. shall have bolted flanged inlets and NPT outlets. 8 in. valves shall have flanged inlets and outlets. Flanges shall be in accordance with ANSI B16.1 for Class 125 iron flanges.
3. The valve shall have three additional NPT connections for the addition of backwash accessories.

B. Design:
1. Both single and dual body valves shall provide an extended body with a through flow area equal to the nominal size. Floats shall be unconditionally guaranteed against failure including pressure surges. A resilient bumper shall be provided on 4 in. and larger sizes to cushion the float during sudden opening conditions. The seat shall provide drop tight shut off to the full valve pressure rating.
2. Dual body valves shall consist of a wastewater air release valve piped to a wastewater air/vacuum valve with a full-ported brass ball valve.
    a. The wastewater air release valve shall have an extended leverage mechanism with sufficient mechanical advantage so that the valve will open under full operating pressure. An adjustable threaded resilient orifice button shall be used to seal the precision discharge orifice in the cover.
    b. The wastewater air/vacuum valve sizes 4 in. and larger shall have a cover fitted to the valve body by means of a machined register to maintain concentricity between the top and bottom guide bushings at all times. The tandem float assembly shall have a hexagonal guide shaft supported in the body by circular bushings to prevent binding from debris. The upper float shall be protected against direct water impact by an internal baffle. The seat shall be a minimum of 0.5 in. thick on 2 in. and larger valves and secured in such a manner as to prevent distortion.
3. Single body valves shall have a full port orifice, a double guided plug, and an adjustable threaded orifice button. The 1 in. body shall be globe style to increase float clearance and reduce clogging. The plug shall be protected against direct water impact by an internal baffle and an extended float stem. The plug shall have a precision orifice drilled through the center stem. The float shall include a sensitivity skirt to minimize spillage.

C. Materials:
1. The valve body and cover shall be constructed of ASTM A126 Class B cast iron.
2. The float, plug, guide shafts, and bushings shall be constructed of type 316 stainless steel. Non-metallic guides and bushings are not acceptable. Resilient seats shall be Buna-N.

2.4 WATER COMBINATION VALVES

A. Connections:
1. Dual body valve sizes 3 inches and smaller and single body valve sizes 4 inches and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection.
2. Larger sizes shall have bolted flanged inlets and threaded or flanged outlets. Inlet flanges shall be in accordance with ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.5 for Class 400 steel flanges.

3. The valve shall have two additional NPT connections for connection to gauges, testing and drainage.

B. Design

1. Both single and dual body valves shall provide a through flow area equal to the nominal size. Floats shall be unconditionally guaranteed against failure including pressure surges. The cover shall be bolted to the body and sealed with a flat gasket. A resilient bumper shall be provided on 4 in. (100 mm) and larger sizes to cushion the float during sudden opening conditions. The resilient seat shall be replaceable and provide drop tight shut off to the full valve pressure rating.
2. Dual body combination valves shall consist of an Air Release Valve piped to an Air/Vacuum Valve with a quarter-turn, full-ported bronze ball valve on 4 in. and larger sizes.
    a. The Air Release Valve shall have a leverage mechanism with sufficient mechanical advantage so that the valve will open under full operating pressure. Simple lever designs shall consist of a single pivot arm and a resilient orifice button. Compound lever designs shall consist of two levers and an adjustable threaded resilient orifice button.
    b. The Air/Vacuum Valve sizes 4 in. (100 mm) and larger shall have a cover fitted to the valve body by means of a machined register to maintain concentricity between the top and bottom guide bushings at all times. The float shall be double guided with a guide shaft extending through the float to prevent any contact with the body. The float shall be protected against direct water impact by an internal baffle bolted to the cover or integrally cast in the body. The seat shall be a minimum of .5 in. (12 mm) thick on 2 in. (50 mm) and larger valves and secured in such a manner as to prevent distortion. Valves with working pressures above 500 psig (3450 kPa) shall have metal seats with synthetic seals.
3. Single body combination valves shall have an expanded outlet to provide full flow area around the guide mechanism. The valve shall have a double guided plug on 2 in. (50 mm) and larger sizes, and an adjustable threaded orifice button. The plug shall be protected against direct water impact by an internal baffle. On valve sizes 4 in. (100mm) and smaller, the plug shall have a precision orifice drilled through the center stem. On valve sizes 6 in. (150 mm) and larger, air release and air/vacuum mechanisms shall be provided as separate units contained within the same body and meet the same design specifications for the Dual Body Combination Valve in section 3.2 above.
4. Floats shall be unconditionally guaranteed against failure including pressure surges. Extended mechanical linkage shall provide suitable mechanical advantage so that the valve will open under full operating pressure.

C. Materials

1. The valve body and cover shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves. Class 300 ductile iron valves shall be constructed of ASTM A536 Grade 65-45-12 ductile iron. Dual Body Class 300 steel valves shall be constructed of ASTM A216 Grade WCB cast steel.
2. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Non-metallic floats, linkage, or bushings are not acceptable. Resilient seats shall be Buna-N. Class 300 steel dual body valves shall have a 316 stainless steel seat with Buna-N seal to provide an initial contact to Buna-N with a final metal-to-metal contact to prevent over compression of the resilient seal.

D. Options

1. Low durometer seat and orifice button shall be furnished for low pressure applications.

2.5 MANUFACTURE

A. The manufacturer shall demonstrate a minimum of (5) years' experience in the manufacture of wastewater air valves. The valves shall be manufactured and tested in accordance with American Water Works Association standard (AWWA) C512. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.

B. The exterior of the valve shall be coated with a universal alkyd primer.

C. Acceptable Manufacturers:
1. Valmatic
2. Or Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Except as otherwise indicated, comply with the following requirements:
1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

D. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

E. Locate all valves in locations which will allow easy operation and facilitates maintenance.

F. Provide chain operators for any valves located more than 8 feet above finished floor. This means double acting lever handles for quarter turn valves, or chain wheels for multi-turn valves. Arrange valves and set up chain length for proper operation.

3.2 ADJUSTING AND CLEANING:

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Piping and Equipment".

3.3 MANUFACTURER'S CUSTOMER SERVICE

A. Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

B. Manufacturer shall also make customer service available directly from the factory in addition to authorized representatives for assistance during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

END OF SECTION

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SECTION 404113 – PROCESS PIPING HEAT TRACING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes plumbing piping heat tracing for freeze prevention, with the following electric heating cables:

1. Plastic insulated, series resistance.

B. Related Sections:

1. Section 220719 – Piping Insulation

1.2 DESIGN AND PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design heat trace system using performance requirements and design criteria indicated.

B. Heat Trace System performance requirements:
1. Heat trace system shall be designed to maintain a minimum liquid temperature of 50 degrees F.
2. Design Heating Load: Design heating load shall be calculated to provide the required liquid temperature above based on the climate data and assuming a sustained wind speed of 20 MPH.
3. Safety factor: 10%
4. Piping insulation: As specified in Section 220719 – Piping Insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For electric heating cable.

C. Delegated Design Submittal: Provide all calculations and sizing for an adequate fully operational system.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLASTIC INSULATED, SERIES RESISTANT HEATING TABLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. HTD Heat Trace, Inc.
   2. Raychem; a brand of Tyco Thermal Controls LLC.
   3. Watts Radiant, Inc.; a subsidiary of Watts Water Technologies, Inc.
   4. Or equal

B. Comply with IEEE 515.1.

C. Heating Element: Single- or dual-stranded resistor wire. Terminate with waterproof, factory-assembled, nonheating leads with connectors at both ends.

D. Electrical Insulating Jacket: Minimum 4.0-mil Kapton with silicone, Tefzel, or polyolefin.

E. Cable Cover: Aluminum braid.

F. Maximum Operating Temperature (Power On): 300 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Capacities and Characteristics:

   1. Maximum Heat Output: 6 W/ft.
   2. Piping Diameter, Materials and Service:
   3. Number of Parallel Cables: As Required
   4. Spiral Wrap Pitch: As Required
   5. System must be provided with an indicator light
   6. Electrical Characteristics for Single-Circuit Connection:
      a. Volts: 120.
      b. Phase: Single

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

   1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
   2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
   3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

4. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 220553 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Install in accordance with manufacturer’s instructions and recommended practices.

C. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Section 220719 "Plumbing Piping Insulation."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

D. Set field-adjustable switches and circuit-breaker trip ranges.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Remove and replace damaged heat-tracing cables.

END OF SECTION

SECTION 407187 – PREFABRICATED FRP PARSHALL FLUME

PART 1 - GENERAL

1.1 SUMMARY

A. Parshall Flume design and materials shall be required for the complete installation of the work.

1.2 REFERENCES

A. Design, fabricate and Parshall Flumes and materials in accordance with manufacturer's recommended procedures and the following codes and standards:

ASTM A193	-	Stainless Steel Anchor Bolts
ASTM D256	-	Izod Impact Strength
ASTM D570	-	Water Absorption Rate
ASTM D638	-	Tensile Strength
ASTM D695	-	Compressive Properties of Rigid Plastic
ASTM D696	-	Coefficient of Linear Expansion
ASTM D790	-	Flexural Properties
ASTM D792	-	Density and Specific Gravity at 23^0 C
ASTM D1056	-	Polymer Grade
ASTM D2583	-	Indentation Hardness
ASTM D2584	-	Resin, Glass & Filler Content
ISO1438/1-1980	-	Open Channel Flow Measurement

B. Composition of the Parshall Flume laminate shall be in accordance with the recommendations shown in the Quality Assurance Report for Reinforced Thermoset Plastic (RTP) Corrosion Resistant Equipment prepared under the sponsorship of the Society of the Plastics Industry, Inc. (SPI), and the Material Technology Institute (MTI) of the Chemical Process Industry for "Hand Lay-Up Laminates," and shall meet the specifications for Type I, Grade 10 laminates shown in Appendix M-1 of said report.

C. Manufacturer shall be experienced in the design and manufacture of specific Parshall Flumes and accessories for a minimum period of 20 years.

D. Manufacturer must provide warranty for 25 years against failure due to corrosion.

1.3 ACTION SUBMITTALS

A. Submit the following for acceptance:

1. Approval Drawings

    a. Showing all critical dimensions.

b. Showing principal parts and materials.

1.4 DELIVERY, STORAGE AND HANDLING

A. Ship all Parshall Flumes with suitable packaging to protect products from damage.

B. Protect flume flanges, tabs and accessories from damage.

C. The flume shall be stored on a smooth flat surface, free of sharp objects, and if laid horizontally, shall be placed in such a way as to avoid structural damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flume body shall be:

1. Engineered composite fiberglass reinforced plastic (FRP).

a. Molded in one piece to create a seamless corrosion barrier impervious to moisture.

b. FRP resin shall be polyester.

c. Flume Hardware (when applicable): T-316L stainless steel.

2.2 PARSHALL FLUMES

A. Acceptable Manufacturers:

1. Plasti-Fab Inc. (or approved equal)

a. Shall be Model 36" Parshall.

2. The flume fabrication, engineering and customer support shall all be provided by the same company. Outsourcing any of these components is not acceptable.

3. To assure quality control and single source accountability the same manufacturer shall fabricate and fully assemble the flume and all components.

4. Or approved equal.

a. Manufacturer must have a qualified Engineer on staff with at least 5 years' experience with hydraulic measurement flumes.

2.3 DESIGN CRITERIA

A. The flume shall be dimensioned and shaped according to Dr. Ralph L. Parshall's design.

B. Composition of the Flume laminate shall be in accordance with the recommendations shown in the Quality Assurance Report for Reinforced Thermostat Plastic (RTP) Corrosion Resistant Equipment prepared under the sponsorship the Society of the Plastics Industry, Inc. (SPI) and the Material Technology Institute of the Chemical Process Industries, Inc. (MTI) for "Hand Lay-up Laminates" and shall meet the specifications for Type 1, Grade 10 laminates shown in Appendix M-1 of said report..

1. Visual inspection for defects shall be made without the aid of magnification and defects shall be classified as shown in Table 1 Level II of ANSI/ASTM D2563-0, approved 1977, (or any subsequent revision).

2.4 CONSTRUCTION

A. Flume

1. Flume throat size shall be 36".

2. Parshall Flume body shall be totally manufactured of fiberglass reinforced polyester.

3. Each Flume shall be molded individually to the exact dimensions specified.

4. The thickness of the walls and floor of the flumes 60" and larger shall be not less than 3/8" (9.5mm) thick, and 7/16" (11mm) thick at the structural flanges. The thickness of the walls and floor of the flumes 48" and smaller shall be not less than ¼" (6mm) thick.

5. Flumes shall be manufactured of reinforced thermoset plastic.

6. Flume inside surface shall be smooth, isophthalic gelcoat of 10 - 20 mil (0.25 - 0.51mm) thickness for UV resistance.

7. The surface shall be free of exposed reinforcing fibers.

8. The minimum glass content shall be 30% exclusive of gelcoat surfaces.

9. The flume shall be reinforced with box section stiffeners down the sides and across the bottom.

10. The stiffeners shall be joined at the knee to form a rigid dimensionally stable flume.

11. Reinforcing shall be designed to provide structural support throughout the length and width of the flume floor.

12. 60" and Larger Parshall Flume body hall have 2" x 3" steel tube laminated to the bottom of the flume to provide additional stiffening for the floor. The steel tubing on the inlet and outlet end of the flume shall extend 3" beyond the side of the flume to assist the contractor in placement, leveling and tie-down of the flume during installation.

13. Flume shall be structurally designed to maintain dimensional integrity with a full head of water while being free standing.

14. Flume shall have a molded-in head gage with dual graduation into the left side of flume.

15. Stiffeners across the top shall be permanent FRP pultruded angle/channel or temporary wood spreaders as required for the job, and shall provide sufficient strength and structural support to resist the stresses that occur during shipping and proper installation of the flume.

B. Accessories (add new, and/or delete unwanted items)

1. T-304 adjustable stainless steel ultrasonic mounting bracket.

2. Pressure probe cavity with lift out bracket.

2.5 PHYSICAL PROPERTIES

A. Structural characteristics for a 1/8" (3mm) glass mat laminate shall meet the following minimum physical properties:

Tensile strength	**15,000 psi (1034 ksc)**
Flexural Modulus	**1,000,000 psi (70307 ksc)**
Flexural Strength	**20,000 psi (1406 ksc)**
Compressive Strength	**22,000 psi (1547 ksc)**
Impact Strength	**9.0 ft-lbs/in. (1.24 kgf.m/25mm)**
Water absorption	**0.13% (in 24 hours)**

2.6 DIMENSIONS

A. The flume shall conform to the physical dimensions listed in Figure 19 of the U.S. Department of Interior, Water Measurement Manual, latest edition. Dimensional tolerances for 1",2", and 3" Parshall flumes shall be plus or minus 1/16" (1.6mm) maximum in the throat, and plus or minus 1/8" (3mm) maximum elsewhere. Dimensional tolerances for all other sizes shall be plus or minus 1/8" (3mm) maximum in the throat, and plus or minus 1/4" (6mm) maximum elsewhere.

PART 3 - EXECUTION

3.1 INSTALLATION

A. PARSHALL FLUMES LARGER THAN 84" WILL BE SHIPPED IN FLANGED AND MATCH-DRILLED SECTIONS ALONG WITH STAINLESS STEEL FASTENERS FOR ONSITE ASSEMBLY.

B. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. Thoroughly clean and remove all shipping materials prior to setting.

D. Install products in accordance with plans, general comments below and the Manufacturer's recommendations.

E. Care shall be taken in the handling, storage and placement of the flume in preparation for installation. The top spreaders shall be left on the flume until after installation is complete. They may be removed after the grout has cured if desired.

F. The flume shall be installed level end-to-end and side-to-side, and must remain level throughout installation. Flume assembly should be set into a pre-poured block-out / channel.

G. The contractor shall provide sufficient shoring and bracing of the floor and sidewalls to prevent lifting, floating, buckling or bulging of the sides and bottom during installation. The side locking clips are not intended to be used as anchorage points. Their function is to key the flume into the grout or concrete.

H. Concrete shall be poured in successive lifts of not more than 6" - 8"(152-203mm) per lift. Extra care shall be exercised during the first pour to insure that grout flows smoothly under the floor, and an even fill is achieved. The first lift shall be allowed to set so that excessive hydraulic forces are not transferred to the bottom of the flume by later lifts.

3.2 ADJUSTMENT AND START UP

A. Check flume for being level both directons, meeting dimensional requirements and cleaned per manufacture's instructions.

B. Site to be left clean and free of any debris.

C. Representative shall complete a Certification of Proper Installation and provide copies to the Owner, Engineer, Contractor and Manufacturing Facility. (When applicable)

END OF SECTION

SECTION 407529 – DISSOLVED AMMONIA ANALYZERS

PART 1 GENERAL

1.1 Section includes

A. Analyzer for monitoring of ammonium in water.

B. Includes the capability to remotely monitor sensors on any browser-enabled device and present diagnostics on the overall health of the measurements (on Predictive Diagnostics-enabled sensors), as well as upcoming and required maintenance - reducing user risk and downtime.

1.2 Measurement Procedures

A. The method of measuring ammonium will be by gas selective electrode (GSE) that uses liquid to gas- phase conversion.

1. Sample is mixed with sodium hydroxide that converts ammonium to ammonia which is expelled from the sample.

2. The ammonia gas can pass the gas selective membrane.

3. Ammonia changes the pH of the electrolyte and the electrode then measures the pH value and calculates the ammonium concentration.

1.3 Alternates

A. Other instruments that do not use a GSE are not acceptable.

B. Other instruments that do not have predictive diagnostic capabilities are unacceptable

1.4 System Description

A. Performance Requirements

1. Measurement range (depending on model):

a. 0.05 to 20 mg/L, or

b. 1 to 100 mg/L, or

c. 10 to 1000 mg/L

2. Lower detection limit (depending on model):

a. 0.05 mg/L, or

b. 1 mg/L, or

c. 10 mg/L

3. Accuracy (depending on model):

a. 3% ±0.05 mg/L, or

b. 3% ±1.0 mg/L, or

c. 4.5% ±10 mg/L

4. Reproducibility (depending on model):

a. 2% ±0.05 mg/L, or

b. 2% ±1.0 mg/L, or

c. 2% ±10 mg/L

5. Response time: Less than 5 minutes (T90) , including sample preparation

(in combination with Hach Filterprobe sc)

6. Measurement interval: 5 to 120 minutes, adjustable

1. When connected to a multi-parameter digital controller the overall status of the instrument performance is displayed as a percentage value via a measurement indicator

2. When connected to a multi-parameter digital controller the overall time remaining until maintenance tasks are due is displayed in days

1.5 Certifications

A. CE conform. Listed to UL and CSA safety standards by TUV.

1.6 Environmental Requirements

A. Operational Criteria

1. Sample temperature: 4 to 40 °C (39 to 104 °F)

2. Sample pH: 5 to 9 pH

3. Operating temperature: -20 to 45 °C (-4 to 114 °F)

4. Operating humidity: 95% relative humidity, non condensing

1.7 Warranty

A. The product includes a one-year warranty from date of shipment.

1.8 Maintenance Service

A. Scheduled maintenance

1. Replace stirrer arm: yearly

2. Replace valve pumps: yearly

3. Replace cylinder and piston: yearly

B. Unscheduled maintenance

1. Replace chemicals as required

2. Replace filter element, fan housing, filter element, and compressor as required

PART 2 PRODUCTS

2.1 Manufacturer

A. Hach Company, Loveland, CO
   1. Model AMTAX sc Ammonium Analyzer

2.2 Manufactured Unit

A. The AMTAX sc Ammonium Analyzer consists of:
   1. Housing: ASA UV-resistant, IP55-rated, lockable
   2. Gas sensitive electrode
   3. Colorimeter

2.3 Equipment

A. The analyzer calibrates and cleans itself automatically.
B. The required power supply is 230 Vac/50Hz or optional 115 Vac/50-60Hz connected to a Hach model sc1000 multi-parameter universal controller.
C. Data transmission is made with a data cable with the controller.
D. Outputs include relay, current outputs, and bus interface via the controller

2.4 Components

A. Standard equipment:

1. Analyzer

2. Manual

3. Reagents

B. Dimensions: 21.3 x 28.3 x 15.4 inches (540 x 720 x 390 mm)

C. Weight: 68 pounds (31 kg)

2.5 Accessories

A. Hach Filterprobe sc

B. Hach sc1000 multi-parameter universal controller

C. Mounting kits (rail or stand)

PART 3 EXECUTION

3.1 Preparation

A. Wall-mount indoors or outdoors.

B. Rail- and stand-mounting options available.

3.2 Installation

A. Contractor will install the sensor in strict accordance with the manufacturer's instructions and recommendation.

B. Manufacturer's representative will include a half-day of start-up service by a factory-trained technician, if requested.

1. Contractor will schedule a date and time for start-up.

2. Contractor will require the following people to be present during the start-up procedure.

a. General contractor

b. Electrical contractor

c. Hach Company factory trained representative

d. Owner's personnel

e. Engineer

3.3 Manufacturer's Service and Start-Up

A. Contractor will include the manufacturer's services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.

B. Contractor will include a manufacturer's Service Agreement that covers all the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first 12 months of end-user operation post turnover.

C. Items A and B are to be performed by manufacturer's factory-trained service personnel. Field service and factory repair by personnel not employed by the manufacturer is not allowed.

D. Use of manufacturer's service parts and reagents is required. Third-party parts and reagents are not approved for use.

END OF SECTION 407529

SECTION 409000 – INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. General requirements which apply to all Instrumentation and Control for Process Systems (hereafter referred to as I&C).

B. Related Sections

1. The Contract Documents are a single integrated document. As such, all Divisions and Sections are applicable. The Contractor and its Subcontractors are responsible to review all parts of the Contract Documents in order to provide a complete and coordinated project.

C. Complete I&C System

1. The requirements for the I&C System shall be the responsibility of a single company hereafter referred to as the Instrumentation Supplier (IS). The IS shall be responsible for all parts of this Section and Sub-Sections as well as all other related sections that may pertain to the I&C System.
2. The Contractor, through the IS and qualified electrical and mechanical installers, shall be responsible to the Owner for the implementation of a complete I&C System. The IS shall provide all necessary coordination, material, and labor such that the entire system be complete and functional. This includes, but is not limited to, the proper operation and monitoring of electrical power systems, process systems, mechanical equipment, instrumentation, control panels, programmable controllers, communications/networking, and SCADA system.
3. The overall I&C system design is based upon non-certified information that has been furnished by various equipment manufacturers and vendors. It is the Contractor's responsibility to include in the bid and installation all labor and material to provide a complete system based upon actual information from equipment being supplied for the project. Any changes or additions due to non-certified manufacturer or vendor information shall be provided at no additional cost to the Owner.

1.2 REFERENCES

A. The installation and commissioning of the I&C System shall conform to all applicable codes, regulations, standards, and specifications, including, but not limited to those listed below. These publications are referenced to by designation but not by edition. The latest edition accepted by the Authority Having Jurisdiction in effect at the time of bid shall govern.

1. State and Local Codes and Authority Having Jurisdiction (AHJ)
2. American National Standards Institute (ANSI)
3. American Petroleum Institute (API)

4. Federal Communications Commission (FCC)
5. Federal Occupational Safety and Health Act (OSHA)
6. International Society of Automation (ISA)
7. Institute of Electrical and Electronic Engineers (IEEE)
8. National Electric Code (NEC).
9. National Electrical Manufacturers Association (NEMA)
10. National Fire Protection Association (NFPA)
11. Underwriters Laboratories, Inc. (UL)

1.3 DEFINITIONS

A. The following definitions may be used throughout this section and subsections (refer to the contract drawings sheet GI-1 for instrumentation abbreviations):

1. CTC: Communications termination cabinet.
2. FAT: Factory acceptance test.
3. HMI: Human machine interface.
4. I&C: Instrumentation and control for process systems
5. IS: Instrumentation supplier.
6. LAN: Local area network.
7. LCP: Local control panel.
8. NC: Normally closed.
9. NO: Normally open.
10. OIT: Operator interface terminal.
11. OSI: Owner's System Integrator.
12. PC: Personal computer.
13. PID: Control action, proportional plus integral plus derivative.
14. PLC: Programmable logic controller.
15. P&ID: Process and instrumentation diagram
16. RIO: Remote input/output
17. SCADA: Supervisory control and data acquisition.
18. SI: System Integrator.
19. UPS: Uninterruptible power supply.
20. VCP: Vendor control panel.
21. WAN: Wide area network

1.4 I&C SYSTEM REQUIREMENTS

A. The Work is to provide a complete and operational I&C System as described by the Contract Documents. This includes, but is not limited, to the following:

1. Before providing a bid as the IS, coordinate with all bidders such that all costs associated with a complete I&C System are accounted for. The Owner shall not be responsible for any additional costs for scope items that have been excluded from the bid as a result of not coordinating with all bidders.

2. The IS shall submit a statement of qualifications verifying that it meets the requirements of 409000.1.8. The IS must be approved by the Engineer before proceeding with the Work.

3. In order to provide a complete system, oversee and coordinate with all equipment and services being provided outside of Contractor's scope.
    a. The Engineer is responsible to ensure that equipment being supplied by others related to the I&C System complies with the requirements of the Contract Documents
    b. The Contractor and IS are responsible to coordinate the installation, commissioning and scheduling of equipment related to the I&C System that are provided by others.

4. Oversee and coordinate with all equipment and services being provided by the Contractor but outside of the IS's scope.
    a. Inform all vendors and suppliers providing equipment related to the I&C System the requirements of Division 40.
    b. The Owner is not responsible for any additional costs incurred by requiring vendors and/or subcontractors to meet the requirements of Division 40.
    c. If a vendor or supplier is unable to meet the requirements of Division 40, the Contractor may submit in writing to the Engineer the reasons for non-compliance. The Engineer will then evaluate the reasons and determine whether a solution may be determined or if a different vendor or supplier is required.
    d. The Contractor and IS are responsible for coordinating with vendors and suppliers the FAT, installation, commissioning, calibration and scheduling for the associated I&C equipment.
    e. The IS is responsible to ensure that panel and loop drawings be supplied for vendor and subcontractor equipment. If the vendors and/or subcontractors are preparing the panel and/or loop drawings, they shall comply with the requirements of Division 40 and shall match those provided by the IS.

5. The IS shall conduct a Pre-Submittal Conference before producing any submittals. The conference should include all parties involved with the I&C System including the Engineer and Owner. The purpose of the conference shall be to review the project as a whole, make sure all parties understand their roles and responsibilities and to go over submittal requirements.

6. Prepare I&C System Submittals which includes the following:
    a. Instrumentation hardware submittal (including TR20 forms).
    b. Control panels design and submittal.
    c. Recommended spare parts submittal.

7. Following submittal approvals, do the following:
    a. Procure all instrumentation hardware and accessories.
    b. Procure hardware for and fabricate all control panels being provided.
    c. Perform FAT's for all control panels being provided.

8. Programming and integration shall be supplied by SKM.

9. Oversee the installation of the I&C System.

10. Perform bench and field calibrations of instruments as required.

11. Oversee and document loop testing.

12. Oversee and document commissioning.

13. Maintain record drawings.
    a. Maintain on the construction site a set of Instrumentation Drawings that shall be continuously marked up during construction.
    b. The drawings should be updated at least weekly and will be checked monthly by the Owner's representative.
    c. Upon completion of startup, submit the marked-up drawings to the Engineer for review and for drafting.

14. Prepare O&M manuals.
    a. Provide O&M manuals in accordance with Section 017823.
    b. Prepare an O&M manual for each major process area or building. Each of these manuals shall be divided into the following categories:
        1) Table of Contents/Index.
        2) Process & Instrumentation Diagrams
        3) Control Panel Record Drawings, Bill of Materials and Design Data.
        4) Record Loop Drawings
    c. Prepare O&M manuals that cover comprehensive information for the I&C System. These manuals shall include the following:
        1) Table of Contents/Index.
        2) Finalized Instrument Summary
        3) Finalized TR20 Instrument Forms
        4) Instrumentation Installation Details
        5) Instrument Operational Manuals
        6) Recommended Spare Parts List

15. Provide training.

1.5 ACTION SUBMITTALS

A. General
1. Submittals for Division 40 shall meet the requirements of Section 013300 Contractor Submittals. In addition, the following requirements shall be met:
    a. Submittals shall include bills of materials with quantities, makes, models, exact part numbers and descriptions.
    b. Edit all submittals such that only pertinent information is submitted. Neatly cross out information that does not apply, options that are not being supplied, etc.
    c. Show product dimensions, construction and installation details, wiring diagrams, and specifications.
    d. If there are exceptions to the Contract Drawings and Specifications, provide a list of exceptions with detailed explanations for the exceptions. The Engineer will review the list of exceptions and determine whether a solution may be determined or if the exception(s) will not be allowed.
2. Furnish submittal required by each Section within Division 40.
3. When submitting on equipment, use the equipment and instrumentation tags depicted in the Contract Drawings.

B. Instrumentation hardware submittal
1. Provide a comprehensive submittal that includes all instrumentation being supplied by the IS. Divide the submittal into the following:

a. Table of Contents/Index.
b. Instrument summary.
c. Instrument TR20 Forms.
d. Instrument Cut Sheets.
e. Instrument Installation Drawings.

2. Provide an instrument summary (sorted by tag number) that has the following information:
   a. Tag number.
   b. Make, model and description.
   c. Associated process.
   d. Location.
   e. Calibrated range.
   f. Referenced loop drawing number and P&ID.
   g. Associated PLC.
3. Furnish TR20 instrumentation forms for each instrument using the forms outlined in ISA-TR20.00.01-2007. This requirement includes all instruments that are being installed as part of the project, whether they are Contractor, Owner and/or Vendor supplied. Show on each sheet who is the responsible party for supplying the instrument. The TR20 sheets should be provided electronically in Microsoft Word or Excel as well.
4. Provide instrument cut sheets for each instrument make and model being supplied for the project. Each cut sheet should have a list of instrument tag numbers that pertain to that particular cut sheet. The cut sheets should have enough information to verify that the instrument conforms to the Contract Drawings and Specifications.
5. Instrument installation drawings
   a. Provide instrument installation drawings for each make and model of instrument being supplied.
   b. Delineate what is being supplied by the IS and what is being supplied by other installers.
   c. Show overall dimensions, mounting locations and elevations.
   d. Show all cabling, conduit and piping locations.
   e. Show the ambient conditions of the location where the instrument is being installed which includes ambient temperature and humidity extremes, whether or not the atmosphere is corrosive and the area classification.
   f. Show mounting requirements, brackets, stands and anchoring.
   g. Show means for sun protection where required.

C. Control panels submittal
   1. Provide a comprehensive submittal that includes all control panels supplied by the IS. The submittal should show that the panels are in conformance with the requirements of Section 409513. Divide the submittal into the following:
      a. Table of Contents/Index.
      b. Panel Bill of Materials and Design Data.
      c. Panel Shop Drawings.
      d. Panel Hardware Cut Sheets.
   2. The Panel Bill of Materials and Design Data shall include the following:
      a. Each panel will have its own Bill of Materials and Design Data information presented in association with the panel drawings. The Bill of Materials shall include all hardware inside or on the enclosure. The design data will include UPS and/or battery load calculations to show that the UPS is sized appropriately for load and for backup time. The design data will show panel weight, materials and finishes. HVAC design data shall be shown. Seismic criteria shall be shown if required by the Contract Documents.

3. Panel Shop Drawings:
    a. Each control panel shall be designed to perform its function(s) as shown in the Contract Drawings. The control panel designs shall take into account information shown throughout the Contract Drawings and Specifications.
    b. Show every internal wire and connection diagrammatically. Show all interfaces between the control panel and external equipment to be connected for power, controls, signal, communications, etc.
    c. All shop drawings shall include a title block with the name of the firm designing the control panels. The title block shall also include project information, Owner information and/or logo, drawing number and description, revision fields and date.
    d. All shop drawings shall be developed utilizing AutoCAD version 2008 or later. All shop drawings should be submitted in PDF and AutoCAD formats and as required by Section 013300.
    e. Panel layout drawing(s):
        1) Each control panel shall have shop drawing(s) which depict the front, back, sides and top/bottom of the panel. This includes showing any hardware mounted on the inside or outside of the panel.
        2) Layout drawings should include subpanel and swing-out panel layouts.
        3) Layout drawings should show locations of panel penetrations for cutouts, conduit entry and/or access plates.
        4) Layout drawings should show all of the components and provide a reference to the bill of materials.
        5) Show the elevations of door devices from the finished floor.
    f. AC and/or DC power distribution diagrams:
        1) Each panel shall show power distribution schematics that show how the panel receives power and feeds all of its internal loads as well as associated external loads.
    g. Communications and/or Network diagrams:
        1) For panels that utilize any means of communications both internally and externally, provide a diagram depicting each communication connection.
    h. Input/Output and/or Internal wiring diagrams
    i. Terminal block diagrams
4. Provide panel hardware cut sheets for each make and model of equipment being supplied for the project. The cut sheets should have enough information to verify that the equipment conforms to the Contract Drawings and Specifications.

D. Recommended Spare Parts Submittal
1. Submit a list of spare parts for all of the equipment associated with the I&C System. The list of spare parts shall include list pricing for each item.
2. Provide the name, address and phone number for each manufacturer and the manufacturer's local sales representative.
3. Indicate whether or not the spare parts are being provided under this contract or not.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.8 QUALITY ASSURANCE

A. All equipment supplied for this project shall meet the requirements of the National Electric Code (NEC) and shall be listed by and bearing the label of the Underwriters' Laboratories (UL).

B. The IS shall be a company that has been actively involved in the installation and commissioning of I&C Systems for a minimum period of five years.

C. The IS shall have adequate facilities, manpower and technical expertise to perform the Work associated with the I&C System and as outlined by the Contract Documents.

D. The IS shall have similar project experience of at least four successfully completed projects for a similar wastewater system. The IS company must have performed similar work for these projects as required herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials provided under this Contract shall be new and free from defects.

2.2 MANUFACTURERS

A. All equipment provided for the I&C System shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

B. Instruments which utilize a common measurement principle (for example, float switches) shall be furnished by a single manufacturer. Panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single manufacturer.

2.3 OPERATING CONDITIONS

A. The I&C System shall be designed and constructed for satisfactory operation and long, low maintenance service under the following conditions:
   1. Environment: Wastewater Treatment Plant.
   2. Temperature Extremes: -4°F to 104°F (Outdoors); 40°F to 104°F (Indoors).
   3. Relative Humidity: 20% to 90%, non-condensing.

B. Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain instrumentation

devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The Contractor shall provide power wiring for these devices. Enclosures suitable for the environment shall be furnished. Instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. After completion of shop assembly, factory test, and approval, equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.

B. Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

C. Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the PCIS. Identification shall be prominently displayed on the outside of the package.

D. Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. If such tests reveal defects, the equipment shall be replaced.

3.2 MANUFACTURER'S SERVICES

A. Manufacturer's services shall be furnished for the following equipment:
   1. Vendor supplied equipment that contains programmable controllers, operator interfaces and/or instrumentation that requires site calibration.
   2. Ammonia Analyzers
   3. Chlorine Analyzers
   4. Phosphorus Analyzers
   5. Dissolved Oxygen Analyzers
   6. Open Channel Flow Meters
   7. Radar Level Transmitters

B. The Contractor shall furnish the following manufacturer's services for the instrumentation listed below:
   1. Perform bench calibration.

2. Oversee installation.
3. Verify installation of installed instruments.
4. Certify installation and reconfirm manufacturer's accuracy statement.
5. Oversee loop testing and pre-commissioning.
6. Train the Owner's personnel.

3.3 INSTALLATION

A. Instrumentation shall be installed per the Instrument Installation Drawings that have been submitted and approved and per the requirements of Division 40. This includes all instrumentation for the I&C System, regardless of who the supplier is. Instrumentation shall be mounted so that it is easily accessible and viewable and such that it does not restrict access to other equipment. Mount instrumentation to pipe stands or wall mounts if they are not directly mounted or if the Contract Drawings indicate otherwise.

B. The I&C System indicated throughout the design are diagrammatic and therefore locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Contractor shall make such changes without additional cost to the Owner.

C. The I&C System is integrally connected to electrical, mechanical and structural systems. Coordinate with these other disciplines the installation of these related components. All conduit, cables and field wiring shall be as required by Division 26.

D. Instruments, control panels and all other I&C System related equipment shall be anchored by methods that comply with seismic requirements applicable to the Site.

E. Each existing instrument to be removed and reinstalled shall be cleaned, reconditioned, and recalibrated by an authorized service facility of the instrument manufacturer. The Contractor shall provide certification of this Work prior to reinstallation of each instrument.

F. The Contract Documents show necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the Engineer for approval prior to commencing that Work. Such changes shall not be a basis of claims for extra Work or delay.

G. Instrumentation, control panels, wiring and all other I&C equipment shall be properly tagged and/or labeled per the requirements of Section 260553.

H. Installation of the I&C System shall be according to the finalized Loop Drawings

3.4 FACTORY ACCEPTANCE TESTING (FAT)

A. The IS shall arrange for the manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the Engineer and Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, and other pertinent systems and devices. A minimum of 10 days notification shall be furnished to the Engineer prior to testing. No shipments shall be made without the Engineer's approval.

B. For each FAT, the IS shall develop and submit a FAT Plan and Procedure Document within 10 days of the FAT. The FAT Plan and Procedure shall as a minimum shall have the following:
   1. Descriptions of test methods to be performed during the FAT.
   2. FAT Schedule and Procedure
   3. FAT Checklists that allow for sign-off and comments for each test method and procedure.

C. Control Panel Completion Test Methods: The following test methods should be performed during the FAT for each control panel:
   1. Completed Shop Drawings: Demonstrate that the control panel has been built according to the shop drawings and that the shop drawings are accurate.
   2. Panel Layout: Demonstrate that the control panel has been laid out as designed and as required by Division 40.
   3. Power Distribution: Demonstrate all power distribution circuits, including but not limited to AC power circuits, UPS operation, signals and circuits and DC circuits.
   4. Control Circuits: Demonstrate the correct installation of each control circuit. Using a signal generator or multi-meter, show the correct operation of each input, output, relay, barrier, buttons, switches, or any other control device. Demonstrate the proper functionality of any hard-wired interlocks that may be associated with each control circuit.
   5. Panel Networking/Communications: If any form of communication is associated with the control panel, verify the proper operation of each communication port and link.

D. Control Loop Test Methods: In order to demonstrate that the control panel will provide its function as intended, provide the following control loop test methods. If programming for the control panel is provided by others, coordinate with the programmer to have all programming completed and tested prior to the FAT. If needed, coordinate to have the programmer present for the FAT.
   1. Alarm Functions: Verify and/or simulate each alarm condition associated with each control loop.
   2. Local Manual and Auto Functions: Verify and/or simulate each Local Manual and/or Auto function associated with each control loop.
   3. SCADA Manual and Auto Functions: Verify and/or simulate each SCADA Manual and/or Auto function associated with each control loop.
   4. Control Loop Interlocks: Demonstrate the functionality of any software interlocks that may be associated with each control loop.

E. If the FAT does not pass and needs to be repeated, the IS shall be responsible for additional per diem costs incurred by the Engineer and Owner.

F. All changes and/or corrections made during the FAT shall be noted on the checklists.

G. Following completion and approval of all FAT, provide the finalized checklists to the Engineer and as part of the equipment shop drawings.

3.5 FIELD QUALITY CONTROL

A. Allow for inspections by the Engineer and/or Owner of the I&C System at any time during the construction. Inspections shall be conducted to verify that the installation is per the requirements of the Contract Documents.

3.6 CALIBRATION

A. Devices provided under Division 40 shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. Each instrument shall be calibrated at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to the National Institute of Standards and Testing.

C. Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the Engineer.

D. Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.

F. For each instrument calibration, provide a calibration sheet and update the corresponding TR20 Instrument Form with the new calibration data. The Calibration sheet shall include the following as a minimum:
   1. Date of calibration
   2. Project Name.
   3. Tag Number.
   4. Manufacturer, model and serial number.
   5. Calibration data including range, input, output and measurement at each calibration point.
   6. Space for comments.
   7. Space for sign-off by party performing calibration.

G. A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The IS shall sign the tag when calibration is complete. The Engineer will sign the tag when the calibration and testing has been accepted.

3.7 LOOP TESTING

A. Each control loop shall have been installed according to the finalized loop drawing. Prior to the commencement of loop testing, the following pre-requisites should have been met:
   1. All associated equipment, conduit and wire have been permanently installed, terminated and inspected.
   2. All wiring has been properly pulled, terminated and labeled.

3. Each wire has been tested with a point-to-point test.
4. All control panels and electrical equipment have been checked out and tested as required by Division 26.
5. All instrumentation has been appropriately installed and calibrated.
6. Loop Test Forms for each loop to be tested have been created and will be available during the loop testing.

B. Each loop test shall have a Loop Test Form prepared and ready prior to each loop test. The loop test form shall have the following:
1. Loop Number and Description
2. Check-Off List with room for sign-off and dated by the IS, Programmer, and Owner's Witness as well as room for comments. The list of items to be checked off for each loop should include but is not limited to the following:
   a. Each power distribution circuit.
   b. Each control circuit.
   c. Each alarm circuit.
   d. Each PLC input/output point.
   e. Each Local Manual, Local Auto, SCADA Manual & SCADA Auto function.
   f. Each hard-wired and software interlock.

C. Upon completion of the above pre-requisites for loop testing, the IS shall oversee and coordinate each loop test. The IS is responsible to be present for all loop testing, whether the equipment was supplied by the IS or not. The IS is responsible to have all responsible parties associated with each loop present. This includes but is not limited to manufacturer representatives, vendor technicians, electrical installers, mechanical installers, and programmer. The IS shall coordinate with the Owner and Engineer to allow for witnessing of loop testing as deemed necessary by the Owner and Engineer.

D. Issues that arise during loop testing should be addressed and fixed immediately. If it is not feasible to immediately fix the issues, the loop testing should be re-scheduled as soon as possible to avoid delays. Any costs associated with re-testing and requiring all parties to return to the site shall in no way be incurred to the Owner.

E. Following a successful loop test, the appropriate parties should sign and date the Loop Test Forms. All Forms shall be certified and submitted to the Engineer as part of the O&M Manuals.

F. Following loop testing, in no way should any parts of the loop be modified. In no way shall any wiring be re-routed or re-terminated. If any such work occurs, all affected loops shall be re-tested at no expense to the Owner.

3.8 COMMISSIONING

A. The IS shall oversee, coordinate and be present during all commissioning activities. The IS shall be responsible for obtaining the assistance of the Contractor and Subcontractors as may be required for commissioning activities.

B. Commissioning shall commence after acceptance of wire test, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with Contract requirements. Pre-commissioning shall demonstrate proper operation of every system

with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.

C. Commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system commissioning and test requirements have been satisfied.

D. Where feasible, system commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software-based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software-based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

E. Electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

3.9 TRAINING

A. Provide training in accordance with Section 409000.

B. Develop a Training Plan for the training requirements of Division 40 and submit it to the Engineer for approval. Coordinate with the Engineer and Owner the time and locations of each training session. Schedule the trainings for after the equipment has been pre-commissioned.

C. As part of the Training Plan, submit a résumé for each individual to be providing training. Training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

D. Each training session shall include a written agenda.

E. The Contractor shall train the Owner’s personnel on the maintenance, calibration and repair of the instruments provided.

F. Within 10 days after the completion of each session, the Contractor shall submit the following:
   1. A list of Owner personnel who attended the training.
   2. A copy of the training materials used during the session with notes, diagrams and comments.

END OF SECTION 409000

SECTION 409113 – CHEMICAL PROPERTIES PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ammonia Process Measurement Devices.
2. Chlorine Process Measurement Devices.
3. Gas Analysis Process Measurement Devices.
4. ORP Process Measurement Devices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each process measurement system shall consist of a sensor and an analyzer/transmitter. Where shown on the drawings, the analyzer/transmitter may be utilized for multiple sensors. When an analyzer/transmitter is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.

B. Each analyzer/transmitter shall be equipped with means to transmit process measurement information to the plant SCADA system.

1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
   a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)
   b. Two programmable SPDT relay outputs, rated at 5A up to 230VAC, for each process measurement

2. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
   a. Hart Protocol

C. Each analyzer/transmitter shall be powered by 115VAC (+/- 10%) at 60Hz unless specifically shown on the drawings as being powered by 24VDC (+/- 15%). Each analyzer/transmitter shall retain its programmable settings in non-volatile memory.

D. Each sensor and corresponding analyzer/transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the analyzer/transmitter shall be protected from the sun such that direct sunlight will not shine on the display.

E. All analyzers/transmitters shall be waterproof and made from corrosion resistant materials.

F. All sensors shall be rated for permanent submersion and shall be corrosion resistant.

2.2 AMMONIA PROCESS MEASUREMENT DEVICES

A. Each analyzer/transmitter should be installed indoors in a room that shall have temperatures not less than 40°F and not greater than 104°F.

B. The ammonia analyzer shall measure free and total ammonia and monochloramine and shall have an accuracy of 0.02 mg/L up to 2.00 mg/L. The analyzer shall utilize a modified Phenate method for colorimetric measurement of the three parameters. The analyzer shall automatically perform calibration, cleaning and self-priming.

C. Provide a grab sample kit for grab-sample analysis without interrupting continuous sample flow to the analyzer.

D. Provide maintenance and calibration equipment necessary to maintain and calibrate the ammonia analyzer for a period of three years. This includes the maintenance kits for replacing tubing, caps and fittings. Provide reagent sets for three years of operation.

E. Acceptable Manufacturers:

1. Hach model APA6000.

2.3 CHLORINE PROCESS MEASUREMENT DEVICES

A. Each analyzer/transmitter should be installed indoors in a room that shall have temperatures not less than 40°F and not greater than 104°F.

B. The chlorine analyzer shall measure free or total chlorine and shall have an accuracy of 0.03 mg/L up to 5.00 mg/L. The analyzer shall utilize the colorimetric with the DPD method for measuring the chlorine.

C. The analyzer shall be equipped with a self-cleaning Y-strainer to prevent fouling. For wastewater effluent applications, install an external 20 mesh Y-strainer for removal of particles larger than 1000 microns. The strainer should be transparent to allow for visible indication of when it should be cleaned. Provide two spare 20 mesh screens for the strainer.

D. Provide maintenance and calibration equipment necessary to maintain and calibrate the chlorine analyzer for a period of three years. This includes the maintenance kits for replacing tubing, caps and fittings. Provide reagent sets for three years of operation.

E. Acceptable Manufacturers:
1. Hach model CL17.

2.4 GAS ANALYSIS PROCESS MEASUREMENT DEVICES

A. Each gas sensor/analyzer shall be provided with a NEMA 4X rating for unclassified areas and NEMA 7 ratings (explosion-proof) for classified areas and specifically listed for Class 1, Division 1 groups B, C and D.

B. All gas analyzers shall be 24VDC powered. Unless specifically indicated otherwise on the drawings, provide for each building with any gas analyzers a 24VDC power supply housed inside of a NEMA 4X enclosure.

C. All analyzers shall have a 4-20mA output for each gas being detected capable of driving a 500-ohm loop load. All analyzers shall have programmable relays rated at 5A up to 230VAC for wiring to a PLC, Horn and/or beacon.

D. Furnish and install a sampling pump module where required to draw an air sample into the analyzer sensor.

E. Infrared type sensors shall be supplied when available for gases being detected.

F. Provide maintenance and calibration equipment necessary to maintain and calibrate the gas analyzers for a period of three years.

G. The following gas detection configurations shall be considered as standard unless shown otherwise on the drawings:

1. Ammonia: 0-100 ppm
2. Carbon Monoxide: 0-500 ppm
3. Chlorine: 0-10 ppm
4. Carbon Dioxide (Infrared): 0-2%
5. Combustible Gas: 0-100% LEL
6. Hydrogen: 0-1000 ppm
7. Hydrogen Sulfide (H_2S): 0-100 ppm
8. Oxygen: 0-25%
9. Sulfur Dioxide (SO_2): 0-100 ppm

H. The gas analyzers shall be furnished with a display that indicates the measured gas level.

I. Acceptable Manufacturers:
1. MSA Ultima X Series
2. Det-tronics

2.5 ORP PROCESS MEASUREMENT DEVICES

A. Each ORP analyzer/transmitter shall be rated for operation with ambient temperature within -4°F to 122°F. If the analyzer/transmitter is to be installed in locations that may experience temperatures less than -4°F, it shall be housed in an enclosure which is equipped with a thermostatically controlled heater. If the analyzer/transmitter is to be installed in locations that may exceed 122°F, it shall be housed in an air-conditioned enclosure. All enclosures and air conditioners shall be rated NEMA 4X.

B. The ORP Sensor assembly shall meet the following criteria:

1. Contain the sensing elements and electronics for digital communications to the analyzer/transmitter in a self-contained, corrosion-resistant and submersible housing.
2. Built-in temperature compensation.
3. Allowed to be installed in liquids whose temperatures are 32 to 200°F and whose pressure is up to 100 psi.
4. The sensor shall have a measuring range of -1500 to 1500 mV.
5. Shall not require sample conditioning or electrolyte solutions.

C. Acceptable Manufacturers:
1. Hach model pHD ORP System with SC200 or SC1000 analyzer/transmitter.
2. WTW/Xylem model SensoLyt 700 IQ pH System with 182 or 2020 analyzer/transmitter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

B. Install all analyzers/transmitters five feet off of floor level. Install in a location that is easily accessible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 409000 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.

2. Test the process measurement system for proper operation at low, mid and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 409000.

END OF SECTION 409113

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SECTION 409119 – PHYSICAL PROPERTIES PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pressure Process Measurement Devices.
   2. Temperature Process Measurement Devices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each process measurement system shall consist of a sensor and an analyzer/transmitter. Where shown on the drawings, the analyzer/transmitter may be utilized for multiple sensors. When an analyzer/transmitter is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.

B. Each analyzer/transmitter shall be equipped with means to transmit process measurement information to the plant SCADA system.

1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
   a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)
   b. Two programmable SPDT relay outputs, rated at 5A up to 230VAC, for each process measurement.

2. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
   a. Hart Protocol

C. Each analyzer/transmitter shall be powered by 115VAC (+/- 10%) at 60Hz unless specifically shown on the drawings as being powered by 24VDC (+/- 15%). Each analyzer/transmitter shall retain its programmable settings in non-volatile memory.

D. Each sensor and corresponding analyzer/transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the analyzer/transmitter shall be protected from the sun such that direct sunlight will not shine on the display.

E. All analyzers/transmitters shall be waterproof and made from corrosion resistant materials.

F. All sensors shall be rated for permanent submersion and shall be corrosion resistant.

2.2 PRESSURE PROCESS MEASUREMENT DEVICES

A. General

1. All inline pressure instruments shall be supplied with isolation ball valve and bleed needle valve for each measurement point. Valve materials shall be selected based upon the properties of the liquid or gas and the atmosphere.

2. Unless otherwise indicated on the Contract Drawings, pressure process measurement devices shall measure process pressure relative to atmospheric pressure (gauge pressure).

3. Pressure process measurement devices which are to measure differential pressure shall have the appropriate inlet and outlet ports and isolation and bleed valves for each port.

4. All pressure instrumentation shall be properly mounted, ideally in locations that are easily accessible and viewable. Supply all appropriate mounting poles, plates and accessories such that each instrument is properly supported and mounted.

B. Inline Pressure Diaphragm Seals

1. Diaphragm seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, flushing connection, and a top housing.

2. The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its measuring element from the process fluid. The space between the diaphragm and the pressure element shall be completely filled with a suitable liquid. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure changes directly to a gauge, transmitter, switch, or other pressure instrument. The diaphragm seal shall have a removable bottom housing to permit servicing. The diaphragm seal shall be factory assembled to the corresponding pressure instrument and be factory-filled. The assembly shall be shipped with a tag reading "Do not disassemble for installation."

3. For sewage, sludge, liquids containing solids, corrosive gases, provide seals with 316SS diaphragm and housing. Nuts, bolts, fill connection and valved flush components shall also be 316SS.

4. For chemical solutions and for liquids or gases that will corrode 316SS, provide seals with PVC body and Viton FKM (for vacuum and up to 15 PSI) or PTFE (for above 15 psi) diaphragm material.

5. Acceptable Manufacturers
   a. Ashcroft model 101 (for 316SS diaphragm seals).
   b. Plast-O-Matic Valves Inc. Series GGS (for PVC body diaphragm seals).
   c. Or Approved Equal.

C. Annular Ring Diaphragm Seals

1. The pressure sensing ring shall measure pressure for 360 degrees around the full inside circumference of the pipeline. The sensing ring shall also be clamped into the body for the full radial width of the sensor. Pressure shall be transmitted to the gauge by a locked in and sealed fluid such as ethylene glycol or silicone oil. The annular seal shall be factory-assembled to the corresponding pressure instrument and be factory filled. The assembly shall be shipped with a tag stating "Do not disassemble for installation."

2. The annular ring shall be rated for ASME classes 150 and 300. It shall be constructed of carbon steel. Instrument connection shall be ¼" NPT.

3. The inside diameter of the sensor shall be the same as the mating pipe for a full uninterrupted flow. There shall be no dead ends or crevices, and flow passage shall make the sensor self-cleaning. The sensor shall have an auxiliary tapped and plugged port to allow connection of other equipment.

4. Wetted parts (liner) shall be capable for continuous duty handling a slurry containing 15 percent solids in a hydrocarbon oil similar to kerosene at temperatures up to 225 degrees F.

5. Acceptable Manufacturers:
   a. Reo Temp ORT, ORR or ORB style
   b. Or Approved Equal.

D. Pressure Transmitters

1. Electronic gauge or differential pressure transmitters shall consist of a capsule assembly, bottom works, vent plug, drain plug, cover flange, ½" NPT process connector and connection, amplifier unit, integral indicator, terminal box with cover, block and bleed valves, and conduit connections.

2. Transmitter shall be rated NEMA 4X. For hazardous locations, it shall be installed with an appropriate intrinsically safe barrier to guarantee the circuit may not abnormally create an ignition.

3. Transmitter shall be of a two-wire, 24VDC loop powered, producing 4 to 20 mA output proportional to the calibrated range of the instrument, capable of driving a 600-ohm load.

4. Static pressure rating shall be a minimum of 500 psig. The maximum over range pressure limit shall be a minimum of 150% of the range. Span shall be adjustable over a minimum of 5:1 range.

5. The 4 to 20 mA signal shall be capable of being calibrated electronically. Output signal damping shall be provided as an internal adjustment. Equipment shall be suitable for an ambient operating range of minus 40 degrees F to plus 212 degrees F. The transmitter shall be equipped with the Hart protocol.

6. Accuracy, including linearity and repeatability, shall be a plus or minus 0.2 percent of span. Gauge pressure transmitters used for flow service shall include square root extraction to produce an output signal linearly proportional to flow. Wetted parts, including block and bleed valve parts, shall be constructed of 316 stainless steel.

7. Acceptable Manufacturers
   a. Dwyer
   b. Vega
   c. Or Approved Equal.

E. Pressure Switches

1. For unclassified locations, pressure switches shall be housed in a NEMA 4X enclosure. For classified locations, pressure switches shall be housed in a NEMA 7 enclosure.

2. Gauge and Differential pressures switches shall be diaphragm-actuated, dual adjustable, with SPDT snap action switch. Contacts shall be rated for a minimum of 5 Amps at 120 VAC. The dead band shall be adjustable up to 60 percent of full scale. Set points shall fall between 20 and 80 percent of the adjustable range. The diaphragm shall be Buna-N, unless

otherwise indicated, and the lower housing shall be brass with a 1/4-inch bottom sensing connection, unless otherwise indicated.

3. Acceptable Manufacturers
   a. Dwyer
   b. Or Approved Equal.

F. Pressure Gauges

1. Pressure gauges shall be 4-1/2 inches in diameter with white laminated dials and black graduations. Windows shall be shatterproof glass acrylic. Gauges shall have a blowout disc and be encased in phenolic, steel, or cast iron. Measuring element shall be a stainless steel bourdon tube with welded, stress-relieved joints. Socket shall have wrench flats. Movement shall be rotary geared stainless steel material. Gauges shall perform as a liquid-filled gauge in a dry gauge and fight against vibration and pulsations. Gauges shall be calibrated to read in applicable units. Accuracy shall be plus and minus 1/2 percent range to 150 percent of the working pressure or vacuum of the pipe or vessel to which they are connected.

2. Acceptable Manufacturers
   a. Dwyer
   b. ReoTemp
   c. Or Approved Equal.

2.3 TEMPERATURE PROCESS MEASUREMENT DEVICES

A. General

1. All temperature sensors or gauges to be used for monitoring temperature of liquids or gases shall be equipped with a thermowell. Thermowells shall have a minimum wall thickness between bore and outside of well of 3/16". . Wells shall have one-inch male NPT process connections except where line classification indicates some other type. Element connections shall be 1/2-inch female NPT. Material shall be Type 316 stainless steel unless the process requires otherwise. Flanged thermowells, where required, shall meet material and size requirements of the line classification. Insertion length shall be specific to the application, not exceeding the manufacturer's published recommendations for the allowable length and for the line velocity.

2. Temperature monitoring instrumentation for HVAC and room temperature monitoring are specified elsewhere.

B. Temperature Sensors and Transmitters

1. Temperature sensors shall be RTD's and shall be 100- or 1000-ohm nominal at 0°C. 1000-ohm sensors shall be used wherever RTD wires to the transmitter or PLC type device exceed 50 feet. All RTD's shall be setup as 3-wire installations.

2. Insertion type RTD's shall be tip-sensitive, platinum 385 in ¼" 316SS sheath with watertight potting. Time constant in agitated water shall not exceed six seconds. RTD

shall comply with International Practical Temperature Scale (IPTS) 68 standards. Accuracy shall be plus or minus 0.1 degrees C. The RTD assembly shall be spring loaded for insertion into a thermowell.

3. RTD only assemblies (typically ran to an RTD input card on a PLC) shall have a stainless steel connection head rated NEMA 4X. It shall have a measuring range of -200°C to 1000°C.

4. Temperature transmitters shall be 2 wire devices with continuously adjustable span and zero adjustments, integral direct reading indicator, solid state circuitry, and a 4 - 20 mA DC output linearly proportional to the indicated temperature span. Transmitters shall be provided with 316 stainless steel thermowell, spring-loading device, extensions, union coupler, and explosion-proof aluminum connection head. Union shall extend out beyond the pipe lagging.

5. Acceptable Manufacturers
   a. Thermowells
      1) Pyromation
      2) Or Approved Equal
   b. RTD only insertion assemblies
      1) Pyromation
      2) Or Approved Equal
   c. Sensor and Transmitter Assemblies
      1) Pyromation
      2) Or Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

B. Install all analyzers/transmitters five feet off of floor level. Install in a location that is easily accessible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 409000 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.

2. Test the process measurement system for proper operation at low, mid and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 409000.

END OF SECTION 409119

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SECTION 409123 – MISCELLANEOUS PROPERTIES PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dissolved Oxygen Process Measurement Devices.
2. Flow Process Measurement Devices.
3. Level Process Measurement Devices.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Instrumentation TR20 forms.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that instruments being provided are compatible with the physical and process conditions associated with the instrument. This includes compatibility with liquids, gases, pressures, temperatures, flows, materials, locations and mounting requirements. Provide all necessary accessories to the instrument for a complete and operable system.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the process measurement equipment as a complete system. Each system shall be properly tagged and identified with its corresponding instrument tag as shown on the P&ID's. Each system shall be factory calibrated and certified prior to delivery.

PART 2 - PRODUCTS

2.1 GENERAL

A. Each process measurement system shall typically consist of a sensor and an analyzer/transmitter. Where shown on the drawings, the analyzer/transmitter may be utilized for multiple sensors. When an analyzer/transmitter is used for multiple sensors, it shall be capable of displaying simultaneously each process measurement.

B. Each analyzer/transmitter shall be equipped with means to transmit process measurement information to the plant SCADA system.

1. For hardwired signals, unless otherwise indicated on the drawings, provide the following:
   a. 4-20mA output signal for each process measurement (for up to 500 Ohm loads)
   b. Two programmable SPDT relay outputs, rated at 5A up to 230VAC, for each process measurement

2. Where shown on the drawings, provide the following digital communications to the plant SCADA system:
   a. Hart Protocol

C. Each analyzer/transmitter shall be powered by 115VAC (+/- 10%) at 60Hz unless specifically shown on the drawings as being powered by 24VDC (+/- 15%). Each analyzer/transmitter shall retain its programmable settings in non-volatile memory.

D. Each sensor and corresponding analyzer/transmitter shall be supplied as a complete and operable system. This includes all cabling, mounting hardware and fasteners. When installed outdoors, the analyzer/transmitter shall be protected from the sun such that direct sunlight will not shine on the display.

E. All analyzers/transmitters shall be waterproof and made from corrosion resistant materials.

F. All sensors to be immersed in liquids shall be rated for permanent submersion and shall be corrosion resistant.

2.2 DISSOLVED OXYGEN PROCESS MEASUREMENT DEVICES

A. Each DO analyzer/transmitter shall be rated for operation with ambient temperature within -4°F to 122°F. If the analyzer/transmitter is to be installed in locations that may experience temperatures less than -4°F, it shall be housed in an enclosure which is equipped with a thermostatically controlled heater. If the analyzer/transmitter is to be installed in locations that may exceed 122°F, it shall be housed in an air conditioned enclosure. All enclosures and air conditioners shall be rated NEMA 4X.

B. The DO Sensor assembly shall meet the following criteria:

1. Contain the sensing elements and electronics for digital communications to the analyzer/transmitter in a self-contained, corrosion-resistant and submersible housing.

2. Built-in temperature compensation.
3. Allowed to be installed in liquids whose temperatures are 32 to 200°F and whose pressure is up to 100 psi.
4. The sensor shall have a measuring range of 0 to 20 ppm.
5. The sensor shall continuously measure dissolved oxygen by exciting a luminescent material and then detecting light emitted by the material that is proportional to the amount of dissolved oxygen in the liquid.

C. Shall not require sample conditioning or electrolyte solutions.

D. Acceptable Manufacturers:

1. Hach model LDO Probe 2 with SC200 or SC1000 analyzer/transmitter.
   a. With Sensor Guard for probe Hach P/N 9253900
2. WTW/Xylem FDO 700 IQ with 182 or 2020 analyzer/transmitter.

2.3 FLOW PROCESS MEASUREMENT DEVICES

A. ROTAMETERS

1. Rotameters in chemical solution lines and where indicated shall have vertical bottom inlets and top outlets with ANSI 150-lb flanged ends for vertical mounting.

2. The meters shall have Hastelloy C floats, 10-inch long scales, and a range of 10:1 with an accuracy of plus or minus 2 percent. Meters shall be rated for a minimum working pressure of 150 psi. Flanged rotameters for chemical solutions and where indicated shall be calibrated in gallons per minute.

3. The bodies shall have union ends for ease of maintenance, polysulphone tubes, aluminum or brass end fittings, Type 316 stainless steel internal parts and scales suitable for the indicated capacity range.

4. The meters shall have accuracy within plus and minus 5 percent of the capacity range indicated.

5. Meters in air and pump seal flushing lines shall be of the modified rotameter design with screwed ends, spring-loaded pistons, and union bodies for mounting in any position.

6. For activated carbon solution, bodies shall be Type 316 stainless steel construction with magnetically actuated float and scale.

7. For other chemicals bodies shall have Type 316 stainless steel ends with heavy borosilicate glass tubes and packing glands or other best suitable material.

8. Rotameters with NPT screwed ends for water, air, and fuel gas service shall be calibrated in gallons per minute or cubic feet per minute. The scales shall be suitable for the capacity ranges indicated.

9. Acceptable Manufacturers:

a. Dwyer UV Series.
b. Krohne VA40 Series.
c. Or Approved Equal.

B. FLOW SWITCHES

1. Thermal dispersion type flow switches

a. Thermal dispersion type flow switches shall be used for pump discharge monitoring, chemical injection monitoring, gas flow monitoring and for flows in pipes with velocities greater than 0.25 fps.

b. The flow element shall be constructed of a material that is best suited for the liquid or gas that it is serving. Typically for chemicals the material will be Hastelloy C and for other liquids or gases it will be 316SS.

c. The switch shall be capable of operating in liquids or gases whose temperatures range from -40°F to 350°F and up to 2000 psi operating pressure.

d. The flow switch assembly shall be insertion type with ¾" male NPT threads. The insertion length shall be such that the thermal dispersion elements are in the center of the pipe.

e. The flow switch shall accept 115VAC or 24VDC as shown on the Contract Drawings. It shall have two SPDT relay outputs rated at 5A up to 240VAC.

f. The flow switch shall be rated to be installed in Class 1, Division I Groups B,C & D hazardous locations. The electronics shall be housed in a powder coated aluminum enclosure that is rated NEMA 4X.

g. Acceptable Manufacturers:
1) Dwyer TDS
2) Fluid Components International (FCI) FLT93 Series.
3) Sierra Instruments Innova-Switch Series.
4) Or Approved Equal.

2. Paddle type flow switches

a. Paddle type flow switches shall be used for low flow, clean water applications such as seal water systems and eyewash stations.

b. The lower and upper housing shall be stainless steel and leak-proof. The machined tee, flow section, and other wetted parts shall be stainless steel with ½" NPT connections.

c. An adjustable bypass valve shall set the trip point of the switch.

d. The snap action switch shall be magnetically actuated and shall be SPDT and rated at 5A up to 250VAC.

e. Acceptable Manufacturers:
   1) Dwyer Low Flow Model V6
   2) Or Approved Equal.

C. OPEN CHANNEL FLOW METER

1. Ultrasonic type open channel flow meters

   a. In applications where level measurement may be used to calculate flow, including flume and weir applications, an ultrasonic transducer and remote transmitter system shall be utilized. For the ultrasonic transducer and remote transmitter system, refer to the requirements of 2.4.I Ultrasonic Level Measuring System.

   b. The ultrasonic open channel flow system shall be capable of internally converting the measured level into the calculated flow value and then displaying it on the screen. The meter shall output a 4-20mA signal that represents the flow rate. It shall also have a contact output that may be used for flow totalization.

   c. Acceptable Manufacturers:
      1) Siemens LT500 (transmitter) with XPS-10/15 (transducer).
      2) Or Approved Equal.

2. Radar/Ultrasonic type open channel flow meters

   a. In open pipe or channel applications where velocity and level measurement may be used to calculate flow, a Doppler radar (velocity) and ultrasonic (level) measurement system shall be utilized.

   b. The flow sensor shall be made of corrosion resistant materials and shall be rated for permanent submergence (IP68). It's operating temperature shall be 14°F to 122°F.

   c. The flow sensor shall be capable of measuring level, average velocity and surcharge depth. The level measuring range is 0.25 – 60" with an accuracy of 1%. The average velocity measuring range shall be 0.75 to 20 fps with an accuracy of 0.5%. The surcharge level sensor shall be a Piezo-resistive pressure transducer with stainless steel diaphragm.

   d. The transmitter shall display the flow rate, total, velocity and level.

   e. Provide a software package by the same manufacturer as the radar/ultrasonic system that is used to commission and maintain the system.

   f. Acceptable Manufacturers:
      1) Hach Marsh-McBirney FLO-DAR model 4900 with FLO-WARE software.
      2)

D. MAGNETIC FLOW METER

1. Materials

a. All mounting hardware shall be 316 stainless steel, the instrument enclosure and the spool mag shall be rated NEMA 4X, the flow sensor liner shall be hard rubber, and the electrode material shall be hastelloy.

b. Spool size shall be as specified on the drawings.

c. All applications with flow element below grade where no de-watering means or in submersible applications shall provide the flow element as NEMA 6P (IP-68).

d. Transmitter shall be integral or remote to the flow element as shown on the P&ID's.

2. Design and fabrication

a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate. The meter shall use a pulsed DC magnetic field excitation.

b. Provide flanged end connections per ANSI B16 rated for piping system operating and test conditions.

c. Operating pressure: 150 psi.

d. Operating temperature: 122°F.

e. Grounding requirements: per manufacturer requirements. Typically inlet and outlet grounding rings of same material as electrode.

f. When the transmitter is remote to the flow element, provide cable between flow element and transmitter. Coordinate with the installer the length of the cable required. No splices in any way will be allowed.

g. Complete zero stability shall be inherent to the meter system. The system shall have a programmable low flow cutoff.

h. Empty pipe detection to prevent false measurement when pipe is empty or partially filled.

i. Forward and reverse flow measurement and totalization as well as net flow totalization.

j. 4-20mA DC isolated output into maximum 800 ohms. Signal shall be programmable to indicate forward and/or reverse flow.

k. Provide a dry contact output for flow direction indication.

l. Provide a programmable frequency output for flow totalization.

m. +/- 0.5% accuracy for flow rates above 1 fps.

3. Acceptable Manufacturers

a. Siemens SITRANS F 5100W.

b. Endress+Hauser Promag 53.
c. Rosemount 8700.
d. ABB WaterMaster.
e. Or Approved Equal.

E. FLOAT SWITCHES

1. Float switches shall consist of a mechanical switch, hermetically sealed in a plastic casing, freely suspended at the desired height from its own cable. When the liquid level reaches the float switch, the casing will tilt and the mechanical switch will change state.

2. The casing shall be constructed of polypropylene with the sheathed cable extruding from the casing. The cable shall be three conductors, made specifically for underwater use and heavy flexing service.

3. The float switch shall have a 10A resistive rating up to 250VAC.

4. Weight and buoyancy shall be such that contaminants like a cake of grease will not result in the float switch changing operating level more than one inch.

5. A NEMA 4X 316SS junction box shall be supplied for termination of the float cable(s) allowing for conventional wiring and conduit to be run from the junction box to a control panel. It shall have terminal blocks for the required number of circuits and shall accept sealed fittings.

6. Float switch cables shall be suspended in a manner that provides minimum strain to the cable and will not damage it. This is typically achieved with a stainless steel cord support grip or strain relief grip as manufactured by Kellems. When support grips are used, a stainless steel hook shall be installed for hanging the support. All screws, fasteners, boxes and grips shall be 316SS. In no way are any steel or galvanized steel components allowed.

7. The float cable length shall be long enough for easily removing the float from the water for testing and long enough to reach its termination junction box.

8. If the float switch is to be installed in a classified area, an appropriate intrinsically safe barrier shall be utilized to guarantee the circuit may not abnormally create an ignition.

9. Manufacturers:
   a. Flygt ENM-10.
   b. Or Approved Equal.

F. FLOOD SWITCHES

1. High level flood switches shall be the type that is suspended on a column. A ¼" NPT connection with flying leads allows the column and float assembly to be attached to a junction box. The junction box shall be rated NEMA 4X and be nonmetallic. The flood switch shall be CPVC and shall be made for use with liquid chemicals and corrosive liquids. Switch contacts shall be SPST N.O. with 20VA rating minimum.

2. If the flood switch is to be installed in a classified area, an appropriate intrinsically safe barrier shall be utilized to guarantee the circuit may not abnormally create an ignition.

3. Manufacturers:
   a. GEMS LS-74780.
   b. Or Approved Equal.

G. SUBMERSIBLE LEVEL TRANSMITTERS

1. The submersible level transmitter shall consist of a submersible transducer, electronic transmitter, support cable, and interconnecting cable with cable shield and vent tube for atmospheric reference. The vent tube shall be provided with a replaceable moisture barrier. The submersible transducer shall be the strain gauge type suitable for sensing pressure equivalent to the liquid level range indicated.

2. The transducer shall have 316 stainless steel process wetted parts and shall be provided with a waterproof interconnecting cable. The transducer shall be suspended by a corrosion resistant cable as recommended by the manufacturer. The installation shall allow easy removal of the transducer and cable assembly for maintenance purposes. The electronic level transmitter shall be remote mounted and shall produce a 4 - 20 mA DC signal linearly proportional to the level range indicated and be capable of driving a load of 700 ohms.

3. The interconnecting cable shall have a pull strength of 200 pounds, be factory attached to the transducer, and shall be terminated in a NEMA 4X 316SS enclosure. The enclosure shall house the vent tube moisture barrier and local indication.

4. The measurement system shall be suitable for the area classification and operation over a temperature range of 32 to 122 degrees Fahrenheit with an accuracy of plus or minus 0.5 percent of span. The transmitter shall have a non-fouling, large diaphragm (greater than 2”). The diaphragm shall be protected by a spacer assembly that also allows the transducer to sit on the floor of the wet well.

5. For lengths greater than 20 feet the transducer shall have ½” threads and shall be suspended in the wet well by ½” stainless steel conduit.

6. Acceptable Manufacturers
   a. Dwyer PBLT2
   b. Dwyer SBLT2 upon approval
   c. KPSI model 750.
   d. Or Approved Equal.

H. FLANGED LEVEL TRANSMITTERS

1. Flanged level transmitters shall be a flanged, differential pressure-sensing unit. The transmitter shall be a 2 wire device with continuously adjustable span, zero and damping adjustments, integral indicator, scaled in engineering units, with a 4 digit LCD display, solid state circuitry, and 4 - 20 mA output with HART protocol. Accuracy shall be 0.075 percent of span. Process wetted parts, bolts, flanges, adapters, drains and vents shall be stainless steel. Body and mounting brackets shall be corrosion resistant and suitable for the environment. The flanged process connection shall be 316SST ANSI Class 150 4-inch

with a 3" 316SST diaphragm. The diaphragm shall extend past the flange such that it is flush with walls of the pipe. The low pressure connection shall be 1/4-inch or 1/2-inch NPT.

2. Components**:** Diaphragm seals shall consist of a flange with flush or extended diaphragm to be flush with the walls of the pipe. It shall have a direct mount, coplanar, welded connection for connection of the transmitter to the seal.

3. Operating Principles: The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its measuring element from the process fluid. The space between the diaphragm and the pressure element shall be completely filled with a suitable liquid that is rated for the environmental conditions. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure changes directly to a gauge, transmitter, switch, or other pressure instrument.

4. Materials: Exposed surfaces, housings, and diaphragm shall be constructed of 316, stainless steel.

5. Acceptable Manufacturers
   a. VEGA with diaphragm seal.
   b. Or Approved Equal.

I. ULTRASONIC LEVEL MEASURING SYSTEM

1. As indicated on the drawings, the ultrasonic level measuring system shall be setup as a level transducer with remote mounted transmitter or as a single transducer/transmitter assembly. For hazardous locations, the single transducer/transmitter shall be utilized. It shall be loop powered and shall be installed with an appropriate intrinsically safe barrier to guarantee the circuit may not abnormally create an ignition.

2. All transducer and transducer/transmitter assemblies shall be rated IP68 for permanent submergence. Remote transmitter shall be in a non-corrosive NEMA 4X housing. Transmitters shall have an LCD display and shall be programmable by buttons on the transmitter or with a handheld programmer. When programmed with a handheld programmer, each transmitter shall be supplied with an accompanying programmer.

3. The transducer shall be encapsulated in chemical and corrosion resistant material, such as Kynar, Teflon or TEFZEL. It shall be capable of operating from -40°F to 158°F. The transducer shall be compatible with the level range as indicated on the Contract Drawings. As a minimum, the transducer shall be capable of measuring a range of 40 feet.

4. When the transducer is remotely mounted from the transmitter, it shall have a waterproof shielded cable whose length is long enough to reach the transmitter. In no way shall splicing of the transducer cable be allowed.

5. Each transmitter shall provide a 4-20mA output signal that is programmable to a user desired level range.

6. Remote transmitters shall be provided to accept two transducers for differential level monitoring or for monitoring two separate levels. A second 4-20mA output signal shall be

provided for the second level. The remote transmitter shall have six programmable relays rated at 5A up to 250VAC.

7. Manufacturers:
   a. Siemens SITRANS Probe LU (transducer/transmitter assembly); LT500 (remote transmitter) with XPS-15 or greater (transducer).
   b. Or Approved Equal.

J. RADAR LEVEL MEASURING SYSTEM

1. The radar level measuring system shall be setup as a single loop powered transducer/transmitter assembly. For hazardous locations, it shall be installed with an appropriate intrinsically safe barrier to guarantee the circuit may not abnormally create an ignition.

2. All transducer/transmitter assemblies shall be rated IP68 for permanent submergence. Transmitters shall have an LCD display and shall be programmable by buttons on the transmitter or with a handheld programmer. When programmed with a handheld programmer, each transmitter shall be supplied with an accompanying programmer.

3. The transducer shall be encapsulated in chemical and corrosion resistant material and shall be hermetically sealed. The antenna supplied (horn or rod) shall be per the recommendation of the manufacturer. It shall be capable of operating from -40°F to 158°F. The transducer shall be compatible with the level range as indicated on the Contract Drawings. As a minimum, the transducer shall be capable of measuring a range of 40 feet.

4. Coordinate with the mechanical installers the method of installing the radar system (flanged or threaded connection). It is critical that the radar level measuring system be installed according to the manufacturer's installation guidelines. Install shield sections if required. Keep the radar emission cone free of interference from pipes, beams, pouring liquids, etc. Locate the assembly away from side walls of tanks or vessels.

5. Each transmitter shall provide a 4-20mA output signal that is programmable to a user desired level range.

6. Provide a software package by the same manufacturer as the radar system that is used to commission and maintain the system. The software shall be able to configure the system, view radar echo profiles and modify the programming to suppress false echos.

7. Manufacturers:
   a. Siemens LR150
   b. VEGA Vegapuls
   c. Or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations and as required by these specifications and contract drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.

B. Install all analyzers/transmitters five feet off of floor level. Install in a location that is easily accessible while as near to the sensor(s) as possible.

3.2 CALIBRATION AND COMMISSIONING

A. A manufacturer representative shall field calibrate the process measurement system as required by section 409000 and per the manufacturer's documented calibration procedure. The system shall be calibrated to the proper ranges as required by the Owner and the Engineer. Where analog signals are connected to local or remote monitoring equipment, verify that the calibrated ranges and scaling of the local and remote indicators are correct.

B. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect the installation of the process measurement systems. Verify that the incoming power is within the required range. Verify the functionality of all output signals and communications connections.

2. Test the process measurement system for proper operation at low, mid and high process conditions.

B. Document data for each measurement and for system calibration. Update the TR20 instrument forms following testing and calibration.

3.4 TRAINING

A. Provide a minimum of four hours of training for each type of process measurement system provided. Provide training in accordance with section 409000.

END OF SECTION 409123

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SECTION 409433 – HUMAN-MACHINE INTERFACES

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the human-machine interfaces (HMI) used for control and monitoring as indicated on the Contract Documents. HMI's include the following:
   1. Operator Interface Terminals (OIT) or touch screens.
   2. Personal Computers or Servers used as HMI's to the SCADA System.

B. For software related to HMI equipment, refer to Section 409600.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

A. Hardware to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that HMI equipment and software being provided is compatible with the requirements. Provide all necessary accessories to the HMI equipment for a complete and operable system.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver the HMI hardware as a complete system in accordance with Section 409000.

PART 2 - PRODUCTS

2.1 OPERATOR INTERFACE TERMINALS

A. OITs shall be furnished with hardware to monitor and control equipment, as listed in the specifications, and shown on the Contract Drawings.

B. OITs shall be 10" color touch screens unless otherwise indicated on the Contract Drawings. Each OIT shall have the following features:
   1. Has serial and Ethernet ports with built-in communications protocols drivers as required by the project.

2. Has associated software for programming the OIT and its screens, database, alarms, etc.
3. Has a 640 x 480 minimum resolution with TFT color screen.
4. Has at least 64MB of memory.
5. Has no limitations on the number of screens or tags that may be used as long as within the memory limitations of the OIT.

C. Acceptable Manufacturers
1. GE QuickPanel
2. Modicon Magelis XBTGT
3. Red Lion CR3000

2.2 SCADA PC HARDWARE

A. Any SCADA PC Hardware is being supplied by others.

PART 3 - EXECUTION

3.1 INSTALLATION

A. OIT's shall be installed on the doors of control panels as shown in the Contract Drawings. The control panel assembly and installation shall be as required by Section 409513.

B. Following control panel Factory Acceptance Testing, OIT's shall be removed from the control panels and put back in their original packaging and shipped to the Site loose. The OIT's shall not be re-installed until they are needed for loop testing. The goal of doing this is to protect the screens from damage during construction. While the OIT's are not in the control panel, cover and seal the open space on the door of the control panels to protect the interior of the panel.

C. OIT's shall be installed in accordance with the manufacturer's installation guidelines and instructions.

D. SCADA PC Hardware shall be installed by others.

3.2 TRAINING

A. Provide training for the OIT hardware supplied for the project as required by Section 409000.

END OF SECTION 409433

SECTION 409443 – PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the programmable logic controllers (PLC) used for control and monitoring as indicated on the Contract Documents.

B. Provide one full version of PLC programming software that is applicable to the PLC hardware being supplied for the project. Include auxiliary software (such as communications software, drivers, networking configuration software, etc.) that may be required for a complete and operable system.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Wiring diagrams showing connections to all devices; input and output (I/O), analog and discrete. The wiring diagrams shall indicate the I/O address point to be used in the PLC programs.

C. Submit calculations that show the following:
   1. PLC Power Supply Budget
   2. Calculated number of I/O quantities required
   3. Estimated PLC memory usage

1.3 QUALITY ASSURANCE

A. Hardware and software to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

B. Examine the Contract Documents and verify that PLC equipment and software being provided is compatible with the requirements. Provide all necessary accessories to the PLC equipment for a complete and operable system.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver the PLC hardware and software as a complete system in accordance with Section 409000.

PART 2 - PRODUCTS

2.1 GENERAL

A. PLCs shall be furnished with hardware and software necessary to monitor and control equipment, as listed in the specifications, and shown on the Plans.

B. Each field input and output shown as an I/O Point shall be connected as per the manufacturers' recommendations.

C. The Contractor shall provide the hardware, software, and installation necessary for connecting additional future equipment as indicated on the Plans. In addition to allocating for future I/O, each PLC shall be supplied with a minimum of 20% spare I/O of each type. In other words, the total I/O for each type shall be (current I/O + future I/O) * 120%. Provide enough panel space to install up to 200% of future I/O modules and/or PLC racks/bases.

D. The type of field input and output shall be defined as follows unless specified otherwise on the plans:
   1. Analog inputs and outputs: 4-20mA DC.
   2. Discrete inputs: I/O device shall be a dry contact, inputs shall be powered by the PLC at 24VDC (preferred) or 120VAC.
   3. Discrete outputs: Isolated dry contact outputs.

E. All PLC I/O shall have I/O modules that are installed and wired at a UL508 Panel Shop. All I/O points shall be wired down to terminal blocks. In no way should field wiring go to any part of the PLC assembly.

F. Vendor and Contractor supplied PLC's shall meet the requirements of this Section and of Division 40. Vendor supplied PLC's shall have a Factory Acceptance Test (FAT) performed by the Vendor as required by Section 409000. Contractor supplied PLC's shall have a FAT performed by the Contractor as required by Section 409000.

G. The PLC shall be capable of handling online program modifications without taking the system offline or requiring a download.

H. Acceptable Manufacturers shall be as noted on the drawings, from the list below.
   1. Allen Bradley CompactLogix
   2. Allen Bradley ControlLogix
   3. Modicon M340
   4. Modicon M580

2.2 PROCESSORS

A. The PLC processor shall be a microprocessor based industrial controller with a temperature rating of 0 to 60 degrees C, and a humidity rating of 5 to 85% non-condensing, minimum.

B. The processor's memory shall be sized according to the number of I/O points and amount of logic required for the application. As a minimum, the memory shall be at least 1 megabyte.

C. The processor shall retain its memory and programming when power is removed.

D. The processor shall have tag-based memory.

E. Processors shall be as indicated on the plans.

2.3 PLC POWER SUPPLY

A. The power supply shall provide power for the processor, and I/O modules. The power supply shall have built-in over voltage and under voltage detection circuitry, protection against overcurrent conditions, and automatic power-up sequence that enables outputs only when proper operating tolerances are reached. Power requirements shall be 24 VDC unless shown as otherwise on the Contract Documents.

2.4 COMMUNICATIONS NETWORKS

A. Each PLC shall be equipped with network ports (and corresponding network modules if necessary) as shown on the Contract Drawings. Each PLC shall be equipped with an Ethernet port for connection to the Plant SCADA System. Additional ports shall be provided for distributed I/O as shown on the Contract Drawings.

B. Ethernet ports shall be setup to communicate with the appropriate Ethernet/IP protocol.

C. PLC serial ports shall be supplied as shown on the Contract Drawings.

D. The PLC shall be programmable through the Ethernet port or through a USB port.

2.5 INPUT/OUTPUT MODULES

A. Only I/O modules that have typical wiring diagrams shown in the Contract Drawings shall be allowed for each PLC.

B. Analog I/O modules shall have a minimum of 12 bits of resolution and shall be setup as 4 to 20 mA signals unless indicated otherwise on the Contract Drawings. Analog inputs shall be setup to be connected to loop powered (2-wire) or self-powered (4-wire) signals. All analog inputs and outputs shall be protected by a fuse. 4 to 20 mA signals shall be protected by a 32mA fuse.

C. Each discrete I/O module shall be fused (fuse body shall be equipped with a blown fuse indicator). Each discrete output module and shall have interposing relays for each point with form C relay contacts. Indicator lights shall also be provided on each I/O point to indicate status of each signal. Each individual input or output point shall be optically isolated to protect the controller I/O circuitry from high voltage transients.

2.6 SPARE PARTS

A. In addition to the spare parts requirements of Section 409000, provide the following:
   1. One spare processor for each type of PLC processor supplied for the project.
   2. One spare I/O card for every type of I/O card supplied for the project.

3. One spare PLC power supply for every type supplied for the project.
4. One spare network adapter for each type of network adapter supplied for the project.
5. One spare base for rack style PLC's.

PART 3 - EXECUTION

3.1 FACTORY ACCEPTANCE TESTING

A. All PLC assemblies shall be built up in control panels and shall be part of a Factory Acceptance Test as required by Section 409000.

3.2 INSTALLATION

A. The PLC assemblies shall be installed in control panels made specifically for the PLC. The control panel assembly and installation shall be as required by Section 409513.

B. The PLC assemblies shall be installed in accordance with the manufacturer's installation guidelines and instructions.

3.3 TRAINING

A. Provide training for the PLC hardware supplied for the project as required by Section 409000.

END OF SECTION 409443

SECTION 409513 – PROCESS CONTROL PANELS AND HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for all control panels and associated hardware for the project. This includes, but is not limited to, vendor control panels, PLC panels, local control panels and instrumentation panels.

B. Related Requirements:
   1. The requirements of Division 26 shall apply to this section.

1.2 ACTION SUBMITTALS

A. Submit the Control Panels Submittal as required by Section 409000.

1.3 CLOSEOUT SUBMITTALS

A. Submit the operation and maintenance data, including record control panel drawings for all control panels as required by Section 409000.

1.4 QUALITY ASSURANCE

A. Referenced Standards:

   1. National Electric Code (NEC).
   2. American Society for Testing and Materials (ASTM).
   3. Joint Industrial Council (JIC).
   4. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Terminal Blocks for Industrial Use.
      b. ICS 6, Enclosures for Industrial Controls and Systems.
      c. 250, Enclosures for Electrical Equipment (1000 V Maximum).
   5. Underwriters Laboratories Inc. (UL):
      a. 50, Enclosures for Electrical Equipment.
      b. 508, Industrial Control Equipment.
      c. 508A, Standard for Industrial Control Panels.

B. Hardware to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. All panels shall be assembled in and labeled by a listed UL 508A panel shop. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

C. Examine the Contract Documents and verify that control panel hardware being provided is compatible with the requirements. Provide all necessary accessories to the control panels for a complete and operable system.

D. The Contractor shall not place any conduit feeds for any control panel until the Control Panel Submittal has been approved. Once approved, conduits shall be placed strategically to best suit the layout of the control panel. Power entry and separation of power, controls and signal shall be considered.

E. All painted control panels shall have matching paint colors and tones.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the control panel hardware as required by Section 409000.

PART 2 - PRODUCTS

2.1 GENERAL

A. All control panels shall have an overall NEMA rating suitable for withstanding the mechanical, electrical, thermal stresses, humidity and corrosion that the panel will be subjected to in its installed location.

B. The following rules shall be followed when determining the NEMA rating requirement for each control panel:

1. NEMA 1, 3 & 3R shall not be allowed for control panels.
2. NEMA 4 shall be utilized for outdoor or wet locations in non-corrosive, unclassified areas. NEMA 4 control panels shall be painted steel.
3. NEMA 4X shall be utilized in corrosive, unclassified areas. NEMA 4X enclosures shall be 316SS except for the following exceptions with which the enclosure shall be polycarbonate or fiberglass reinforced polyester (FRP):
    a. Chemical areas or rooms.
    b. Locations where stainless steel is incompatible.
    c. Where specifically noted on the Contract Drawings.
4. NEMA 7 shall be utilized for classified areas as required by NEC. NEMA 7 enclosures shall be constructed of cast aluminum.
5. NEMA 12 shall be utilized in dry, non-corrosive, unclassified areas. NEMA 12 control panels shall be painted steel.

C. Each source of foreign voltage shall be isolated by providing disconnecting or pull-apart terminal blocks or a disconnect operable from the control panel front. Each control panel shall be provided with identified terminal strips for the connection of external conductors. The SUPPLIER shall provide sufficient terminal blocks to connect 30 percent additional conductors for future use.

D. PLC Discrete outputs from the control panel shall be provided by electrically-isolated contacts rated for 10 amps at 120 VAC. Analog inputs and outputs shall be isolated 4 to 20 mA, 2 wire signals with power supply.

E. Control panel mounted devices shall be mounted a minimum of 3-feet above finished floor elevation. Touchscreens shall be mounted at a height of 66” from the finished floor to the center of the touchscreen. All control panels will be situated on housekeeping pads, this is not considered the finished floor elevation.

2.2 ENCLOSURES

A. Enclosures shall be either freestanding, pedestal-mounted or equipment skid-mounted, as indicated. Internal control components shall be mounted on an internal back-panel or side-panel as required.

B. Enclosure dimensions indicated on the Contract Drawings are based upon non-certified information and shall be considered the minimum panel size. It is the responsibility of the Contractor to design the size of all control panels. When sizing the control panels, adhere to the following criteria:
   1. Maximum panel depth is 24”. If there are special reasons for a deeper enclosure, approval must first be obtained from the Engineer.
   2. The panel size shall provide space for all equipment, wire-ducts, wire, terminations, and space for future expansion.
   3. If the panel size needs to be enlarged, coordinate with the installing Contractor that there is adequate space for the larger size. If there is not space, coordinate with the Engineer to come up with a solution.

C. Materials
   1. Steel panel section faces shall be 12-gauge minimum thickness for free standing panels and 14-gauge minimum thickness for wall-mounted or pedestal-mounted panels. Materials shall be selected for levelness and smoothness.
   2. Structural shapes and strap steel shall comply with ASTM A 283 - Low and Intermediate Tensile Strength Carbon Steel Plates, Grade C.
   3. Bolting Material: For outdoor, wet or corrosive areas, all bolting materials shall be 316SS. In dry, non-corrosive locations, carbon steel may be used. Commercial quality bolts, nuts, and washers shall be 1/2-inch diameter with UNC threads. Carriage bolts shall be used for attaching end plates. Other bolts shall be hex end machine bolts. Nuts shall be hot pressed hex, American Standard, heavy. Standard wrought washers shall be used for foundation bolts and attachments to building structures. Other bolted joints shall have SAE standard lock washers.
   4. Control panels shall be structurally designed such that the completed and installed control panels shall safely withstand seismic requirements for the project. All equipment mounted within the panel shall be properly braced to prevent damage during a seismic event.

D. Acceptable Manufacturers
   1. Hoffman.
   2. Saginaw.
   3. Schneider
   4. Or Approved Equal.

2.3 CONTROL PANEL ASSEMBLY

A. General

1. The following requirements must be met when mounting to the back panels or side panels of the control panel:
    a. Holes shall be drilled and tapped with less than 50% diminishment in thread.
    b. Backpan shall be cleaned front and back after any drilling and tapping.
    c. Tek Screws are not acceptable.
    d. Any component mounted to a back panel or side panel shall be mounted at an exact square to the vertical and horizontal planes.
    e. Any duct running between back panels and side panels shall align horizontally with no overlaps.
    f. All DIN rail mounted to the panels shall have ½" stand-offs allowing for wires and other equipment to be routed beneath the rail if necessary.
2. Enclosure doors shall be flush fitting, gasketed, and be of the hinged lift-off type with lockable door handles. A common key shall be provided for the doors on each panel assembly. Removable access panels shall be provided with dished handle fasteners. Screwdriver 1/4 turn or Dzus type fasteners are not acceptable.
    a. The flanged edges of panels shall be straight and smooth. Corners shall be welded and ground smooth.
    b. The face of the panel shall be true and level after flanging.
    c. Panel cutouts and holes may be cut or drilled by any standard method that does not cause deformation. Burrs shall be ground smooth.
    d. Adjacent panels shall assemble with faces flush. Gaps or cracks shall not be visible from the front of the assembled instrument board.
    e. Panels shall be self-supporting.
3. Control panels that are supplied with three phase power and/or are powering motor loads shall be supplied with a main feeder disconnect that is door operated. The door operator for the disconnect shall be defeat-able with a screwdriver. If the upstream overcurrent protection device feeding the control panel is not in the same room as the control panel, provide a main circuit breaker as part of the main disconnect assembly. Fused disconnects shall not be used unless specifically shown on the Contract Drawings.

B. Preparation of Bare Metal Panel Surfaces

1. Grind high spots, burrs, and rough spots.
2. Sand or sandblast to a smooth, clean, bright finish.
3. Every trace of oil shall be removed with a solvent.
4. Apply the first coat of primer immediately.

C. Panel Finishing

1. Repair damaged primer on inside surfaces.
2. Apply primer to the entire panel surface.
3. Apply 2 coats of satin finish lacquer enamel over the entire surface.
4. Colors shall match original paint color.

D. Instrument Finishing: The final coat applied to painted surfaces of instrument cases, doors, or bezels which are visible from the front of panels shall be manufacturer's standard unless otherwise indicated. Black japan or "crinkle" finishes on instrument cases are not acceptable.

E. Mounting of Instruments

1. The panel shop shall provide cutouts and shall mount instrument items indicated to be panel mounted, including any instruments indicated to be furnished by other vendors but installed in the panel.
2. The panel shop shall also mount behind the panels other instrument accessory items as required.
3. Equipment mounted at the rear of panel shall be installed to allow for commissioning adjustments, servicing requirements, and cover removal.
4. Spare space shall be kept clear of wiring, etc., to give maximum space for future additions.
5. All equipment mounted with fasteners shall be mounted with grade 5 or greater Phillips head fasteners.

F. Electrical Requirements
1. Each panel shall be serialized with its own UL serial number and label.
2. Each terminal block shall have a printed label as shown on the panel drawings. Handwritten labels in any location of the panel will not be accepted. Wiring shall be identified with printed tubular wire end markers.
3. Back panels and side panels shall have visible machine printed adhesive labels that detail the following items:
    a. Terminal block torque ratings for field connections.
    b. Terminal block sections as detailed in the panel drawings.
    c. All equipment within the panel including, but not limited to, PLCs, switches, circuit breakers, UPS, Power Supplies, and any other piece of equipment.
4. Screw torque shall not exceed 0.4 N*M (4.4 Lb*In) (7 Lb-In).
5. Wire duct for AC signals and wiring shall be light grey. All duct for DC signals shall be white. Wiring for AC circuits and DC circuits must be kept within their respective ducts.
6. Freestanding panels shall be provided with switched lighting as indicated in the panel drawings.
7. Freestanding panels shall be provided with a 15-amp, 120-volt, service outlet circuit within the back-of-panel area as shown in the panel drawings.
8. Wall-mounted or pedestal-mounted panels shall be sized to adequately dissipate heat generated by equipment mounted in or on the panel.
9. Outdoor panels shall be provided with thermostatically controlled heaters to maintain inside temperatures between above 40°F.
10. Any panel with heat producing equipment such as a PLC, UPS or VFD shall have cooling capabilities to maintain the inside temperature below 104°F.
11. All outdoor panels equipped with heating and/or cooling shall be insulated with a minimum R value of 2.0.
12. Provide a laminated fuse list matrix detailing fuse numbers and sizes mounted on the inside of the enclosure door. The fuse list matrix must be easily visible and at minimum size 14 font. Handwritten fuse matrices will not be accepted. See panel drawings approximate locations.
13. Provide a pocket mount on the inside of each panel door large enough to hold type 8.5 x 11 size paper. See panel drawings for approximate locations. Pockets must be accessible with no equipment obstructing the entrance of the pocket for at least ten inches above the pocket. The pocket mount shall be fastened. No adhesive type pockets allowed.
14. Where required crimped fork or ring terminals will be properly installed on the conductors for connection integrity.
15. Signal and Control Circuit Wiring
    a. Wire type and sizes: Conductors shall be flexible stranded tin machine tool wire, UL 1015 listed Type MTW, and shall be rated 600 volts. Wires for instrument signal

circuits and alarm input circuits shall be 14 AWG. Other wires, including shielded cables, shall be 16 AWG minimum.

b. Wire Insulation Colors: Conductors supplying 120 VAC power on the line side of a disconnecting switch shall have black insulation for the ungrounded conductor. Grounded circuit conductors shall have white insulation. Insulation for ungrounded 120 VAC control circuit conductors shall be red. Wires energized by a voltage source external to the control panel shall have yellow insulation. Insulation for DC conductors shall be blue.

c. Wire Marking: Wire numbers shall be marked using white numbered wire markers made from plastic-coated cloth, Brady Type B 500 or equal, or shall be heat shrink plastic. Wire labels must be machine printed. All conductors within the control panel are to be permanently marked with wire labels at each end. Wire labels are to correspond to the labels on the approved shop drawings.

d. For case grounding, panels shall be provided with a ground lug complete with solderless connector for one no. 1 AWG bare stranded copper cable.

e. Panel doors shall be connected to panel ground.

f. Wire Fastening: Provision shall be made utilizing cable tie bases such as type CTM1 or equivalent, fastened inside the wire duct to allow for the fastening of the shop wire harnesses upon final installation.

16. Power Supply Wiring

a. Unless otherwise indicated, control power shall be 120 VAC. Where the electrical power supply to the control panel is something other than 120 VAC, the control panel shall be provided with a control panel transformer. Control conductors shall be provided in accordance with the indicated requirements.

b. At a location near the top of the panel (or bottom), the panel fabricator shall provide terminal box connections for the main power supply entry.

17. Signal Wiring

a. Signal wire shall be shielded twisted pair or triads. Cable shall be 18 AWG copper signal wires.

b. Color code for instrument signal wiring shall be as follows:

1) Positive (+) – Red or Clear

2) Negative (-) – Black

c. Multiconductor cables where indicated shall consist of no. 16 AWG copper signal wires twisted in pairs with 90-C, 600 V fault insulation. A copper drain wire shall be provided for the bundle with a wrap of aluminum polyester shield. The overall bundle jacket shall be PVC.

d. RTD cabling shall be Belden 8770 cabling or equal.

e. Multi-conductor cables, wireways, and conduit shall be sized to allow for 25 percent spare signal wire.

18. Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and be secured to the inside face of the panel using adhesive mounts.

19. Wiring to rear terminals on panel-mount instruments shall be in plastic wireways secured to horizontal brackets above or below the instruments in about the same plane as the rear of the instruments.

G. Labor and Workmanship: Panels shall be fabricated, piped, and wired by fully qualified workmen who are properly trained, experienced, and supervised.

2.4 CONTROL PANEL COMPONENTS

A. Nameplates and labels

1. All control components within the control panel shall be labeled with adhesive labels that have a thermal transfer type ink system on a UL-508A approved label. Labels shall be provided for marking wire ducts, terminal block sections, PLC modules, networking modules, signal isolators, intrinsic barriers, relays, breakers, power supplies, surge suppressors and all other pertinent components within the control panel.
2. All components on the exterior of the control panel shall have nameplates fabricated from black-letter, white-face laminated plastic engraving stock, Rowmark Ultramatte or equal. Engraved characters shall be block style with no characters smaller than 1/8 inch. Adhesive shall be high strength, low profile double strength, double sided as produced by Bron or Tessa or approved equal. Stainless steel fasteners shall be used in addition to the adhesive on all equipment where the fasteners do not derate the NEMA rating of the enclosure.

B. Pilot Devices

1. Provide pilot devices from a single manufacturer.
2. Pilot devices shall have NEMA ratings that match the overall control panel rating. They shall be 30mm in diameter and heavy duty.
3. All pilot devices shall have an associated nameplate that clearly describes the function of the device.
4. Pilot lights shall be LED and shall have colors as follows:
    a. The Contract Drawings shall take precedence for light colors. Refer to the P&ID's and schematics.
    b. On/Running/Opened: Green.
    c. Off/Stopped/Closed: Red.
    d. Power: White.
    e. Alarm/Fail: Red.
5. Acceptable Manufacturers
    a. Square D Types K (for NEMA 4 or 12) or Types SK (NEMA 4X).
    b. Allen-Bradley Types 800T (NEMA 4/12) or Types 800H (NEMA 4X, 7).
    c. Or Approved Equal.

C. Door Mounted Meters

1. Digital Process Meters
    a. Provide digital process meters to display a numeric process value as required by the Contract Drawings.
    b. The meter shall accept and re-transmit an analog input signal which is in proportion with the process value. The meter shall be capable of receiving the following signals:
        1) 0 or 4 to 20 mA current.
        2) 0 to 5 or 10 DC volts.
        3) RTD and Thermocouple type inputs.
    c. The meter shall be programmable to scale the numeric display to process engineering units. It shall be capable of showing up to three decimal points.
    d. The meter shall be capable of powering the input and re-transmitted signal.
    e. Acceptable Manufacturers:
        1) Precision Digital Trident Series.

2) Red Lion PAX Series.
3) Or Approved Equal.

2. Elapsed Time Meters (ETM)
   a. Provide ETM's for each motor and/or machine provided for the project. Each ETM shall accumulate hours in tenths of an hour.
   b. The ETM enclosure shall be panel mount, polycarbonate, shock resistant and totally sealed.
   c. Acceptable Manufacturers:
      1) Hobbs 20000 Series.
      2) Or Approved Equal.

D. Terminal Blocks

1. Terminal blocks shall mount on standard DIN rail and be of the size required for conductors therein. A minimum of 25 percent spares shall be provided in each terminal box. No more than 2 conductors shall be allowed per termination. Jumper bar assemblies shall be installed for interconnecting terminal blocks, distributing power and signal commons. Terminal blocks shall be U.L. rated for 600 Volts, and 30 Amps, minimum.
2. Grounding terminal blocks shall be provided for instrumentation cable shields. The terminal blocks shall have distinctive 2-color bodies yellow and green and shall be mounted to the DIN rail with metal screw down type clamps, providing a positive ground connection. One grounding terminal block shall be installed for every 2 instrument cables terminated. Grounding terminal blocks shall be U.L. rated for 600 Volts, and 20 Amps, minimum.
3. Terminal blocks shall be available in a variety of colors, including red, green, blue, gray, black, yellow, and orange.
4. DIN mount fuse holders shall have blown fuse indicators for DC and AC circuits. Fuse holders shall be of the compression clamp type. Fuse holders shall be U.L. listed and rated for 600 Volts. Fuse sizes shall not exceed the U.L. current rating for the fuse holders.
5. Terminal blocks for 4 to 20 milliamp signals shall have knife disconnect switches, and accessible test points for testing and measurement of current loop signals, without the need for removing wire terminations.
6. Approved Manufacturers
   a. Phoenix Contact UT Series.
   b. Allen-Bradley 1492 Series.
   c. Or Approved Equal.

E. DIN Rail

1. DIN rail shall be prepunched, RoHS compliant, treated with galvanic zinc plating and passivation. Symmetrical DIN rail shall be 35 mm X 15 mm.
2. Acceptable Manufacturers
   a. Iboco Omega 3AF.
   b. Or Approved Equal.

F. Wire Ducts

1. Wire ducts shall have narrow slots (approximately every ½") to accommodate high-density terminal blocks and other hardware.
2. Wire ducts shall be made of lead-free PVC, shall be UL rated for continuous use up to 122°F, and shall be flame retardant.

3. Wire duct colors shall be as follows:
    a. Light grey for all wiring 120V and higher.
    b. White for all wiring 48V and lower.
    c. Blue for all intrinsically safe wiring.
4. Acceptable Manufacturers
    a. Panduit Type F Series.
    b. Or Approved Equal.

G. Surge Protection Devices

1. Provide a Surge Protection Device (SPD) for power feeds which feed power to the control panel.
2. Each SPD shall have a short circuit current rating that exceeds the rating of the power feed that it is protecting.
3. All SPD's shall be properly grounded to the ground grid per NEC and per the SPD manufacturer's recommendations.
4. Three phase power feeds and single-phase power feeds for non-sensitive loads.
    a. Provide a parallel, DIN rail mountable, SPD whose location is immediately downstream of the main panel disconnect or circuit breaker.
    b. Capable of handling a 10kA surge current.
    c. Acceptable Manufacturers
        1) Transtector 12R Series.
        2) Or Approved Equal.
5. Single phase power feeds for control panels with sensitive electronics
    a. Provide an inline, DIN rail mountable, SPD that also provides EMI filtering.
    b. The SPD shall be capable of handling a 10kA surge current.
    c. The inline SPD shall have a set of dry contacts that indicate when the unit is healthy and operating correctly.
    d. Acceptable Manufacturers
        1) Phoenix Contact SFP Series.
        2) Or Approved Equal.
6. Low Voltage Signals
    a. Provide surge protection for low-voltage signals where shown on the Contract Drawings.
    b. Acceptable Manufacturers
        1) Phoenix Contact Termitrab.
        2) Or Approved Equal.
7. Coaxial Transmission Lines
    a. For radio type systems, provide surge/lightning protection for all coaxial lines leaving the control panel.
    b. Surge/lightning protectors shall be rated for the frequency at which signals are to be transmitted on the cabling.
    c. Acceptable manufacturers
        1) Polyphaser.
        2) Or Approved Equal.

H. Circuit Breakers

1. Circuit breakers shall meet the requirements of Section 262816.
2. Provide a main circuit breaker with panel disconnect if required as described in 2.3.A.
3. All control panels fed by 120VAC shall have a main DIN rail mounted circuit breaker.

4. The following types of loads shall be individually fed by circuit breakers:
    a. Panel mounted receptacles.
    b. UPS equipment.
    c. DC Power Supplies.
5. Circuit breakers shall be sized according to the loads they are powering.
6. Acceptable Manufacturers
    a. Square D.
    b. Cutler Hammer.
    c. Or Approved Equal.

I. Motor Controllers

1. All motor controllers shall meet the requirements of Division 26.

J. Uninterruptible Power Supplies (UPS)

1. All UPS equipment shall meet the requirements of Section 263353.
2. UPS equipment intended to be installed in control panels shall meet the following criteria:
    a. The UPS shall be UL listed and shall maintain the UL listing of the control panel.
    b. The UPS shall be properly mounted to withstand vibration and seismic requirements for the project.
    c. The UPS shall be sized for 200% of the calculated panel load.
    d. The UPS shall have a minimum backup time of 30 minutes unless specifically stated as otherwise on the Contract Drawings.
    e. For PLC panels, the UPS shall be equipped with dry contacts for monitoring the UPS for any alarm conditions and low battery.
3. Where specifically shown on the Contract Drawings, an industrial DC UPS may be used as backup power for the control panel. This will typically be the case where all critical loads are at 24VDC.
4. Unless indicated otherwise on the Contract Drawings, the UPS equipment shall be the line-interactive type and operate at 120VAC.
5. UPS equipment shall provide surge, EMI
6. Acceptable Manufacturers
    a. Powerware 5000 series (line-interactive) or 9000 series (online).
    b. Sola SDU Series (24VDC UPS).
    c. Or Approved Equal.

K. Power Supplies

1. Provide 24VDC Power Supplies or other DC voltages as required for the application.
2. All power supplies shall be oversized for a minimum 150% of the calculated load.
3. All power supplies shall be properly protected by a DIN rail mount circuit breaker whose trip rating is per the manufacturer's recommendation.
4. All power supplies shall have a set of dry contacts that indicate when the power supply is operating normally.
5. Where shown on the Contract Drawings, provide redundant power supplies and corresponding diodes.
6. Power supplies shall meet the following criteria:
    a. Input Voltage: 100 to 240VAC.
    b. Output Voltage: ±1% of rated output.
    c. Operating Temperature: 0°C to 60°C.

d. Built in transient surge protection.
e. DIN rail mountable, metal housing.

7. Acceptable Manufacturers
   a. Phoenix Contact Quint Series.
   b. Or Approved Equal.

L. Signal Isolators/Converters

1. Furnish signal isolators as required that optically isolate the input signal from the output signal. If output signal is to be a different type of signal than the output than the isolator shall convert the signal as required.
2. Isolators output shall be adjustable for zero and span.
3. If input signal is part of a Hart system, the isolator shall be made specifically to pass on the Hart signal.
4. Acceptable Manufacturers
   a. Phoenix Contact.
   b. Action Instruments.
   c. PULS Dimension Series
   d. Or Approved Equal.

M. Intrinsically Safe Barriers

1. Provide intrinsically safe barriers wherever analog or discrete input signals are coming from classified areas.
2. Intrinsically safe barriers shall be located in their own enclosure whose assembly is UL rated. Install the barriers and field wiring as per the requirements of NEC and the manufacturer's installation guidelines.
3. If input signal is part of a Hart system, the isolator shall be made specifically to pass on the Hart signal.
4. Acceptable Manufacturers
   a. Phoenix Contact.
   b. Pepperl Fuchs.
   c. Schneider Harmony Series
   d. Or Approved Equal.

N. Relays

1. Provide relays whose contact ratings are sized according to the load requirements and size of the protection device associated with the circuit in which the contacts are wired. As a minimum contact ratings shall be 10A resistive up to 250VAC.
2. Provide relays whose coil voltage is as required by the application.
3. Relays with DC rated coils shall have a freewheel diode installed across the coil.
4. Relays with AC rated coils shall have a surge suppressor installed across the coil.
5. Relays shall have based with relays which plug into the base. Bases shall have screw-type connections.
6. Relays shall have an LED indicating when the relay is coil is energized.
7. Provide enough relay contacts for each relay as required by the application. If the number of contacts required exceeds the number of contacts on the relay, provide additional relay(s) to provide enough sets of contacts.
8. Acceptable Manufacturers
   a. Idec R Series.

b. Schneider RUMC series
c. Or Approved Equal.

O. Time Delay Relays

1. Provide time delay relays to control on and off delay times as required by the application.
2. Time delay relays shall meet the requirements of relays as listed above with the following additional requirements:
   a. Time delay shall be adjustable from 0.1 seconds to 600 hours.
   b. Timers shall be multi-function and shall be capable of providing on-delay, off-delay, cycle timing and one-shot type timing control.
3. Acceptable Manufacturers
   a. Idec RTE Series.
   b. Phoenix Contact ETD Series.
   c. Or Approved Equal.

P. Panel HVAC Components
1. Provide heating, ventilation, and air conditioning, devices in order to maintain all components within the control panel within the acceptable range as specified in Section 409000.
2. HVAC equipment shall maintain the required NEMA rating for the control panel assembly.
3. Externally mounted HVAC equipment (such as air-to-air exchangers or air conditioners) shall be housed in an enclosure whose material matches the material of the control panel. Where in corrosive environments, all components that will come in contact with outside air shall be corrosion resistant for that environment.
4. All HVAC equipment shall be UL rated. For equipment mounted on the control panel, the equipment shall have a corresponding NEMA rating.
5. Provide power as required for the HVAC equipment. HVAC loads shall be included in feeder and control power transformer sizing calculations.
6. Panel Heating
   a. Heating shall be provided when ambient temperatures are expected to fall below the allowed range as specified in Section 409000. As a minimum, heating shall be sized to keep the panel temperature at or above 50°F.
   b. Except for small anti-condensating heaters, heating equipment shall have fans which distribute the heat throughout the enclosure. Heaters shall be installed according to the manufacturer's installation instructions. Provide enough space between the heating equipment and other components such that the other components to not experience abnormally high temperatures.
   c. Provide anti-condensating heaters for all outdoor enclosures which house electronics, instrumentation and/or motor controllers.
   d. All heaters shall be thermostatically controlled by a DIN rail mounted thermostat.
   e. Acceptable Manufacturers
      1) Hoffman.
      2) Or Approved Equal.
7. Panel Ventilation
   a. Where ventilation is determined to maintain the control panel's maximum temperature as required by Section 409000, the following requirements shall be adhered to:
      1) Ventilation shall maintain the required NEMA rating for the control panel assembly.

2) For indoor, non-corrosive locations (panels with NEMA 12 ratings), conventional ventilation with fans and vents may be used.
3) For corrosive or outdoor locations, side or top mounted air-to-air heat exchangers shall be used.

b. The fan(s) and corresponding vents or air-to-air heat exchangers shall be properly sized and located to move enough air through the panel to remove the generated heat as well as allow air flow across all heat generating equipment.

c. All ventilation shall be thermostatically controlled by a DIN rail mounted thermostat.

d. Acceptable Manufacturers
1) Hoffman.
2) Pfannenberg.
3) Or Approved Equal.

8. Panel Air Conditioning

a. Where it is deemed necessary to air condition a control panel to maintain the control panel's maximum temperature as required by Section 409000, the following requirements shall be adhered to:
1) Air conditioners shall be side or top mounted and shall be sized based upon the heat generated within the control panel, the maximum outside air temperature, and the amount of sunlight the control panel may be exposed to. Air conditioners shall be oversized by a safety factor of 25%.
2) Air conditioners shall be thermostatically controlled by a DIN rail mounted thermostat. In addition, the air conditioner shall turn off if the panel door(s) are not closed.

b. Acceptable Manufacturers
1) Hoffman.
2) Pfannenberg.
3) Thermal Edge.
4) Kooltronics.

PART 3 - EXECUTION

3.1 FACTORY ACCEPTANCE TESTING

A. All control panels shall be factory acceptance tested (FAT) as required by Section 409000.

3.2 INSTALLATION

A. All control panels shall be installed according to the requirements of Section 409000.

B. All control panels shall be installed so that their surfaces are plumb and level.

C. All control panels shall be properly mounted so as to withstand the seismic requirements for the Site. Anchor panels securely to the wall or floor at each corner as a minimum.

D. Control panels shall have been designed according to locations for conduit entry. Floor mounted panels in electrical rooms shall have cutouts in the bottom of the enclosure that were cutout by the panel shop. All conduit holes shall be cut in the field.

E. Field wiring
   1. Wires that are terminated in control panels after permanent panel installation are deemed as field wires. Field wiring shall be installed in the allocated wire ducts and shall be properly labeled and terminated.
   2. All field wires shall be long enough to reach each corner of the enclosure. Neatly coil up extra wire length at the bottom of the enclosure. Do not use the wire ducts for storing extra wire length.

3.3 FIELD QUALITY CONTROL

A. Refer to Section 409000.

END OF SECTION 409513

SECTION 409533 – PROCESS CONTROL NETWORKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structured Cabling System (SCS).
2. Communications Termination Cabinets (CTC).
3. Process Control Network Components.

B. Related Sections

1. The requirements of Division 26 shall apply to this section.

1.2 DEFINITIONS

A. The following definitions may be used throughout this section and subsections (refer to the contract drawings sheet GI-1 for instrumentation abbreviations):

1. CTC: Communications termination cabinet.
2. HMI: Human machine interface.
3. LAN: Local area network.
4. LCP: Local control panel.
5. OIT: Operator interface terminal.
6. OSP: Outside Plant.
7. PC: Personal computer.
8. PLC: Programmable logic controller.
9. SCADA: Supervisory control and data acquisition.
10. SCS: Structured Cabling System.
11. UPS: Uninterruptible power supply.
12. WAN: Wide area network.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each CTC cabinet supplied.

C. Network Drawings: Submit drawings for physical connections between all network hardware.

D. Exchange of Technical Information: During the period of these submittals, the Contractor shall authorize a direct, informal liaison with the Engineer for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as indicated may be authorized informally by the Engineer but will not alter the scope of work or cause an increase or decrease in the Contract Price. During this informal exchange, no oral statement by the

Engineer shall be construed to give approval of any component or method, nor shall any statement be construed to grant exception to or variation from these Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Submit the operation and maintenance data, including record drawings as required by Section 409000.

1.6 QUALITY ASSURANCE

A. Referenced Standards:

1. National Electric Code (NEC).
2. American Society for Testing and Materials (ASTM).
3. National Electrical Manufacturers Association (NEMA).
4. Underwriters Laboratories Inc. (UL).
5. Telecommunications Industry Association / Electronic Industries Association (TIA/EIA) 568B – Commercial Building Telecommunications Cabling Standards.
6. TIA/EIA 569B – Commercial Building Standard for Telecommunications Pathways and Spaces.
7. International Standards Organization/International Electrotechnical Commission (ISO/IEC) 11801 – Information Technology – Generic cabling for customer premises.
8. Institute of Electrical and Electronic Engineers (IEEE)

B. Hardware and software to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functionality of the work.

C. Examine the Contract Documents and verify that Process Control Network equipment and software being provided is compatible with the requirements. Provide all necessary accessories for the Process Control Network for a complete and operable system.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver the Process Control Network hardware and software as a complete system and as required by Section 409000.

1.8 SPECIAL WARRANTY REQUIREMENTS

A. The Contractor shall provide a Ten (10) year warranty on the following items:

1. Fiber Optic Cabling.
2. Fiber Optic Terminations and Cross-Connect Equipment.
3. Outside-Plant (OSP) Category 6 Cabling.
4. Copper Patch Panels and Indoor Category 6 Cabling.
5. CTC Hardware (excluding UPS and other electronic devices).

B. Extended Period for Correction of Defects: The Contractor shall correct all defects in the SCS upon notification from the OWNER within 2 years from the date of Substantial Completion. Corrections shall be completed within 5 days after notification.

PART 2 - PRODUCTS

2.1 GENERAL

A. Current Technology: Cabling, Hardware and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

B. Hardware Commonality: All like equipment shall be provided by a single manufacturer.

2.2 EQUIVALENT PRODUCTS

A. Equivalent products may be considered for substitution for those products specified, however, the equivalent product must be approved, and show demonstrated and documented equivalence to the product specified. Documentation shall include, but is not limited to: product samples, data sheets, and actual test data. The request for product substitution and supporting documentation must be submitted in writing prior to submitting the bid. Written approval for product substitution must be submitted with the bid.

2.3 FIBER OPTIC CABLING

A. Fiber optic cabling shall be provided between facilities and furnished with the quantity of fibers as designated on the contract drawings.

B. All fiber in a cable run shall be from the same manufacturer and shall be the same type. A mix of fibers from different manufacturers may not be used without written permission.

C. Fiber optic cabling exposed to the elements shall be an armored type fiber optic cable.

D. No fiber splicing or closures are allowed except to replace existing splices.

E. Singlemode Fiber

1. All singlemode fiber optic cables within the premises shall use graded-index fibers with 9 micron cores only.
2. Optical Specifications
   a. Fibers shall have dual wavelength capability at 1310nm and 1550nm.
   b. Attenuation: ≤ 0.4 dB/km at 1310nm and 0.3 dB/km at 1550nm.

c. Bandwidth: Operation of 10 Gigabit Ethernet at 10,000 meters at 1310nm and 30,000 meters at 1550nm.
d. Numerical Aperture: 0.14.

3. All fibers shall be color coded to facilitate individual fiber identification. Fibers shall have CPC® or approved equivalent color coatings that resist color degradation, minimize microbending losses and improve handling. The coating shall be mechanically strippable.
4. Dimensional Specifications
   a. Core Diameter: 8.2 µm
   b. Cladding Diameter: 125.0 ± 0.7 µm
   c. Core-Clad Concentricity: ≤ 0.5 µm
   d. Cladding Non-Circularity: ≤ 0.7%
   e. Coating Diameter: 242 ± 5 µm
   f. Coating-Cladding Concentricity: < 12 µm
5. Environmental Specifications
   a. Operating Temperature: -60ºC to +85ºC
   b. Cable shall be UV resistant, waterproof and corrosion resistant.
6. Mechanical Specifications
   a. Minimum tensile strength: 100,000 psi
   b. Fiber Minimum Bending Radius: 0.75 Inches
   c. Cable Minimum Bending Radius (During Installation): 20 times cable diameter
   d. Cable Minimum Bending Radius (After Installation): 10 times cable diameter
   e. Cable shall be rated for Underground, Buried and Aerial, OSP
   f. Cable shall bear OFNP (Plenum Rated), OFNR (Riser Rated) and/or appropriate markings for the environment in which they are installed.
   g. Cable shall utilize 3.0mm buffer tubes containing up to twelve 250 µm color-coded optical fibers.
7. Fiber Cabling shall contain the number of fibers specified in the Drawings.
8. Acceptable Manufacturers
   a. Corning SMF-28e+.
   b. Or approved equal.

F. Multimode Fiber

1. All multimode fiber optic cables shall use graded-index fibers with 50 micron cores only.
2. Optical Specifications
   a. Fibers shall have dual wavelength capability at 850nm and 1300nm.
   b. Attenuation: ≤ 3.0 dB/km at 850nm and 1.5 dB/km at 1300nm.
   c. Bandwidth: Effective Modal Bandwidth of 4700 MHz*km and shall guarantee operation of 10 Gigabit Ethernet at 550 meters at 850nm.
   d. Numerical Aperture: 0.200 ± 0.015.
3. All fibers shall be color coded to facilitate individual fiber identification. Fibers shall have CPC® or approved equivalent color coatings that resist color degradation, minimize microbending losses and improve handling. The coating shall be mechanically strippable.
4. Dimensional Specifications
   a. Core Diameter: 50 ± 2 µm
   b. Cladding Diameter: 125.0 ± 2.0 µm
   c. Core-Clad Concentricity: ≤ 1.5 µm
   d. Cladding Non-Circularity: ≤ 1.0%
   e. Core Non-Circularity: ≤ 5.0%
   f. Coating Diameter: 245 ± 5 µm
   g. Coating-Cladding Concentricity: < 12 µm

5. Environmental Specifications
    a. Operating Temperature: -60ºC to +85ºC
    b. Cable shall be UV resistant, waterproof and corrosion resistant.
6. Mechanical Specifications
    a. Minimum tensile strength: 100,000 psi
    b. Fiber Minimum Bending Radius: 0.75 Inches
    c. Cable Minimum Bending Radius (During Installation): 20 times cable diameter
    d. Cable Minimum Bending Radius (After Installation): 10 times cable diameter
    e. Cable shall be rated for Underground, Buried and Aerial, OSP
    f. Cable shall bear OFNP (Plenum Rated), OFNR (Riser Rated) and/or appropriate markings for the environment in which they are installed.
    g. Cable shall utilize 3.0mm buffer tubes containing up to twelve 250 µm color-coded optical fibers.
7. Fiber Cabling shall contain the number of fibers specified in the Drawings.
8. Acceptable Manufacturers
    a. Corning LANScape Class.
    b. Or approved equal.

G. Innerduct

1. Inner duct shall be used where space is available. All new and spare 2" conduits shall use inner duct with the fiber optic cable.

H. Buffer Tube Fiber Fan-Out Kits

1. Buffer Tube Fan-Out Kits shall be supplied for the termination of each buffer tube at end of the installed fiber cables.
2. Fan-Out Kits shall be color coded to match the color scheme of the fiber cabling.
3. Fan-Out Kits shall have a minimum length of 25 inches.
4. Acceptable Manufacturers
    a. Corning FAN-BT25-12.
    b. Or Approved Equal.

I. Fiber Optic Connectors

1. Fiber Optic Connectors shall be of ceramic construction and shall have a loss $\leq$ 0.5 dB. They shall be made specifically for the type of fiber being connected to and required bandwidth. The connector shall have no metal parts.
2. Fiber Optic Connectors shall utilize the ST type connector.
3. Acceptable Manufacturers
    a. Corning 95 Series.
    b. Or Approved Equal.

J. Fiber Patch Cords

1. The fiber patch cord shall be duplex and consist of buffered, graded-index fiber with a 50 or 62.5 µm core for multimode and 9 µm for singlemode and a 125 µm cladding. The fiber cladding shall be covered by aramid yarn and a jacket of flame-retardant PVC.
2. The fiber patch cord shall be rated for 10 Gigabit Ethernet.
3. For 50 µm multimode the cords shall be Aqua in color.
4. For 62.5 µm multimode the cords shall be Orange in color.

5. For singlemode the cords shall be Yellow in color.

2.4 Fiber Testing and Termination Toolkits and Training

A. Fiber Termination Toolkit shall be provided to the Owner following the completion of the SCS installation. The Toolkit shall be compatible with the Connectors used for terminating the fiber cabling and shall have the necessary components to make at least 100 additional terminations.

B. The Toolkit shall contain hard copies of installation instructions as well as an installation video that illustrates the step-by-step procedure for installing the Fiber Optic Connectors.

C. The Toolkit shall have test equipment that is capable of determining if a Connector was installed correctly.

D. The Toolkit must be an approved installation system of the manufacturer of the fiber optic cabling and connectors.

E. Acceptable Manufacturers
1. Corning SP1000 (polishing/termination kit).
2. Fluke FTK 1450 (fiber testing kit).
3. Or Approved Equals.

F. The Contractor is to provide two four-hour sessions of training. These sessions will be with select city staff and focus on the use of the polishing kit to replace damaged terminations. Each trainee shall have the opportunity to use the polishing kit during these training courses. The Contractor shall also provide a DVD with step-by-step instructions and demonstrations on the polishing process.

2.5 COPPER NETWORK CABLING

A. Outside Plant Cabling (OSP)

1. All building-to-building copper network cabling shall be shielded and shall be rated as outside plant (OSP), Category 6 cables.
2. The cabling shall be terminated in the CTC in each building and shall be punched down at the patch panel on the CTC. The shield shall be grounded only on one end of the cable inside the CTC.
3. Shielded OSP Category 6 Specifications
   a. Category 6 Transmission performance characterized to 500MHz.
   b. Aluminum metallic shield tape for protection against EMI/RFI
   c. Four 23 AWG solid twisted pairs
   d. UV/Sunlight resistant black jacket
   e. Acceptable Manufacturers
      1) Superior Essex BBDN6.
      2) Or Approved Equal.

B. Indoor Cabling

1. Network cabling from the CTC's to wall jacks, control panels, MCCs, phones and all other Ethernet devices shall utilize Category 6 unshielded cable. The Category 6 cable shall be rated for Plenum use if it is run through any Plenum rated areas, otherwise it shall be rated for Riser use.
2. The following color scheme shall be utilized for indoor network cabling:
    a. Blue – Wall Jacks network connections
    b. Gray – Control Panels or MCCs
    c. Yellow – Patch Cables within the CTC
    d. Black – Outside Plant (OSP) cables
    e. Red – Security System / Fire System Cables
    f. White – Wall Jack phone connections
    g. Pink – Miscellaneous Ethernet devices
3. Unshielded Category 6 Specifications
    a. Category 6 Transmission performance characterized to 500MHz.
    b. Four 23 AWG solid twisted pairs
    c. Plenum rated cable shall have FEP insulation with a FRPVC jacket.
    d. Riser rated cable shall have FRPE insulation with a PVC jacket.
4. Acceptable Manufacturers
    a. Superior Essex Series 77.
    b. Or Approved Equal.
5. Patch Cords
    a. Patch cords shall be TIA/EIA Category 6 Compliant. Cords shall be straight through unless cross-over is necessary. Cords shall be 24AWG stranded copper with FRPE insulation and a PVC jacket. RJ45 jack shall have contacts with 50 micro-inch gold plating and a high-impact, UL 94V-0 rated thermoplastic housing.
    b. Patch cords shall have a molded boot cover for protecting the RJ45 connector.
    c. All patch cords in the CTC shall be yellow.

2.6 CROSS-CONNECT EQUIPMENT

A. Cross-Connect Housings shall be provided within each CTC for permanent termination of the fiber optic cabling. The Housing shall be 19" rack mountable and shall be capable to support the termination of four 12-strand fiber optic cables.

B. Cross-Connect Housings when being provided in industrial enclosures such as PLC panels shall be panel mounted. The Housing shall be capable of supporting the termination of four 12-strand fiber optic cables.

C. The Housing shall be suitable for both loose tube, tight-buffered and optical fiber ribbon cables.

D. Acceptable Manufacturers
1. Panduit FMD Series (19" Rack Mount).
2. Panduit FWME Series (Wall Mount).
3. Or Approved Equal.

E. Adapter Panels for the Cross-Connect Housings shall utilize ST type connectors. Multimode adapter panels shall have ST Duplex Connectors, shall be of ceramic construction for bandwidths of 4700 MHz, shall have a loss $\leq$ 0.5 dB. Singlemode adapter panels shall have 6 ST Duplex Connectors, shall be of ceramic construction for singlemode fiber, shall have a loss $\leq$ 0.5 dB.

2.7 COMMUNICATIONS TERMINATION CABINETS (CTC)

A. CTC's shall be 19" rack type systems that shall be able to support and organize electronic equipment, cross-connection and/or termination hardware for fiber optic cabling, station cabling, riser cabling, or building entrance cabling as may be required by design. The rack face shall have a conventional equipment mounting width of 19".

B. The rack must be designed for cable and jumper management and have hardware to organize and support cabling and patch cords in the vertical and horizontal planes. The rack system shall be equipped for electrical grounding to meet EIA/TIA 606 Standards. The fastening system for the equipment shall facilitate easy installation with roll-formed threads in the screw holes for greater strength and durability. The mounting screws shall have pilot points.

C. For NEMA 1 enclosures, all rack components shall be charcoal black in color and made of lightweight 6061-T6 extruded aluminum. For NEMA 4X enclosures the enclosure shall be 304SS.

D. The rack shall be shipped with all necessary hardware to assemble the included frame. It shall be packed in cartons with suitable shipping inserts such that no damage occurs to the rack finish. The finish shall not be scratched, chipped or marred.

E. Each CTC cabinet shall be supplied with a dedicated 20A, 120VAC circuit with associated receptacle mounted in the back of the cabinet.

F. Free Standing Rack Specifications

1. Self-Supported Rack Framework
    a. The self-supporting equipment rack shall be inside the CTC. Standard grade frames shall be capable of supporting equipment to be mounted inside the CTC.
    b. Dimensions: As required to fit in CTC with 19-inch center mounting and a minimum of 67" of usable vertical space. Base Footprint of 20.25" wide by 36" deep.
    c. Hole Pattern: EIA310-D 5/8" – ½" alternating.
    d. Mounting Screws: #12-24 thread combination Phillips/straight heads and pilot points.
    e. Materials: 6061-T6 high strength aluminum.
    f. Flanges: Flange edge to edge internal measurement is 17.75"
2. Racks shall be mounted inside NEMA 1 Enclosures with front and rear access doors.
3. Enclosures shall have glass front doors and solid vented rear doors.
4. Approved ground lug and #6 AWG jacketed green ground wire.
5. CTC shall be installed with at least 36" clear working space in front and behind cabinet.
6. Minimum 72" tall free-standing enclosures.
7. Equipped with a slide-out shelf suitable for a laptop computer to be placed on it for system configuration/programming. The shelf shall be vented.
8. Equipped with a vertical power strip installed with a minimum of 10 outlets rated at 15 amps. The vertical power strip shall be surge protected.
9. Approved Manufacturers
    a. Great Lakes.
    b. Rittal.
    c. CPI.
    d. Or Approved Equal.

G. NEMA 1 Wall Mount Rack Specifications

1. Self-Supported Rack Framework
    a. The self-supporting equipment rack shall be inside the CTC. Standard grade frames shall be capable of supporting equipment to be mounted inside the CTC.
    b. Dimensions: As required to fit in CTC with 19 inch center mounting. Base Footprint of 20.25” wide by 24” deep.
    c. Hole Pattern: EIA310-D 5/8” – ½” alternating.
    d. Mounting Screws: #12-24 thread combination Phillips/straight heads and pilot points.
    e. Materials: 6061-T6 high strength aluminum.
    f. Flanges: Flange edge to edge internal measurement is 17.75”
2. Racks shall be mounted inside NEMA 1 Wall Mount Enclosures with a double hinge system allowing front and rear access.
3. Enclosures shall have glass or plexiglass front doors and solid vented rear doors.
4. Approved ground lug and #6 AWG jacketed green ground wire.
5. CTC shall be installed with at least 36” clear working space in front and 36” on the hinge side of the cabinet to allow access to the rear.
6. Panel mounting height shall be such that the top of the wall mount CTC does not exceed 80” above the finished floor.
7. Approved Manufacturers
    a. Great Lakes.
    b. Rittal.
    c. CPI.
    d. Or Approved Equal.

H. NEMA 4X Wall Mount Rack Specifications

1. Self-Supported Rack Framework
    a. The self-supporting equipment rack shall be inside the CTC. Standard grade frames shall be capable of supporting equipment to be mounted inside the CTC.
    b. Dimensions: As required to fit in CTC with 19-inch center mounting. Base Footprint of 20.25” wide by 24” deep.
    c. Hole Pattern: EIA310-D 5/8” – ½” alternating.
    d. Mounting Screws: #12-24 thread combination Phillips/straight heads and pilot points.
    e. Materials: 6061-T6 high strength aluminum.
    f. Flanges: Flange edge to edge internal measurement is 17.75”
2. Racks shall be mounted inside NEMA 4X Wall Mount Enclosures with a double hinge system allowing front and rear access.
3. Enclosures shall have glass or plexiglass front doors and solid vented rear doors.
4. Approved ground lug and #6 AWG jacketed green ground wire.
5. CTC shall be installed with at least 36” clear working space in front and 36” on the hinge side of the cabinet to allow access to the rear.
6. Panel mounting height shall be such that the top of the wall mount CTC does not exceed 80” above the finished floor.
7. Approved Manufacturers
    a. Hoffman Protek Series.
    b. Or Approved Equal.

2.8 CTC HVAC EQUIPMENT

A. All CTC cabinets shall be properly designed to maintain the inner temperatures of the enclosure within the allowed limits defined in Section 409000.

B. Any HVAC equipment shall maintain the NEMA rating of the CTC assembly.

C. Preferably, fans, air-to-air exchangers and AC units are mounted on the top of each CTC.

2.9 PATCH PANELS

A. Each CTC cabinet shall be supplied with a 19" rack mountable 110 punch down to RJ45 jack patch panel. The panel shall be rated for CAT6 cabling.

B. The 110 punch blocks shall support wiring and be labeled for both T568A and T568B standards. The patch panel shall have at a minimum 24 RJ45 ports and at least 12 spare ports. Each RJ45 port shall have a plastic label holder for custom labels.

2.10 WALL JACKS AND PLATES

A. Jacks shall be TIA/EIA Category 6 Compliant and shall support wiring and be labeled for both T568A and T568B standards. Plates shall be constructed of high-impact, flame-retardant, UL 94V-0 thermoplastic. Plates shall be available in single gang with 1-4 ports and double gang with 8 ports. Color of jacks and plates shall be determined by the Owner.

2.11 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Each CTC shall have a UPS as sized on the drawings installed in it for surge protection and battery backup of critical network equipment. The UPS shall be 19" rack mountable and shall be mounted with sliding rails where possible.

B. Each UPS shall be capable of running the connected load for a minimum of 30 minutes.

C. UPS Electrical Input Specifications

1. Nominal Voltage: 120VAC
2. Voltage Range: 80-144VAC
3. Input Power Factor: > 0.95
4. Frequency: 60 Hz ±3 Hz.

D. UPS Electrical Output Specifications

1. Voltage Regulation: ± 3% of Nominal
2. Efficiency: > 85%
3. Frequency Regulation: ± 3 Hz on utility, ± 1 Hz on battery

E. UPS Communications Specifications

1. A USB port shall be available for monitoring and configuring the UPS. An appropriate cable and software shall be supplied to connect to the UPS with a PC.
2. An Ethernet port shall be available as an option with the ability to monitor and configure the UPS over an Ethernet network.

F. UPS Battery Specifications

1. All batteries shall be sealed, lead-acid batteries and shall be maintenance free. Batteries shall be hot-swappable. The UPS will indicate when the battery is weak and needs to be replaced.
2. The UPS shall be able to accept additional battery modules to extend the runtime of the UPS.

G. Acceptable Manufacturers
1. APC Smart-UPS Series.
2. Powerware 5 or 9 Series.
3. Or Approved Equal.

2.12 NETWORK SWITCHES

A. Each CTC shall contain a rack mountable network switch as indicated in the Contract Drawings.

B. Each PLC cabinet shall contain a DIN rail mountable network switch as indicated in the Contract Drawings.
1. Network switches shall be N-Tron managed switches

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies which it provides. The Contractor shall employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies it provides.

B. All components of the SCS shall be the installation responsibility of the Contractor unless specifically noted otherwise. After the installation of the SCS is completed, the installation shall be inspected jointly by the Contractor and the Equipment Manufacturer's representatives. Any problems shall be corrected, and when both are satisfied with the installation, a written certification of the installation shall be delivered to the Engineer. The certification shall state that all cabling and terminations have been inspected and are installed in accordance with the manufacturer's guidelines.

C. All installations shall be done in conformance with EIA/TIA 568B standards and with the manufacturer's installation requirements. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Contractor to provide in a timely fashion the additional material and labor necessary

to properly rectify the failure. Any and all damage to the cables during the construction of this project is the sole responsibility of the Contractor.

D. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 12 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 24 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 48 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 6 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: 3 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

5. Separation between Cables and Electrical Motors and Transformers: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 6 inches.

E. Miscellaneous Equipment. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire molding, and support hardware, etc., necessary to facilitate the installation of the CTCs within the SCS. All metal fasteners and straps in corrosive or wet areas shall be 316SS.

F. Special Equipment and Tools. It shall be the responsibility of the Contractor to furnish any special installation equipment or tools necessary to properly complete the SCS. This may include, but is not limited to, tools for terminating cables, testing and splicing equipment for copper/fiber cables, communication devices, jack stands for cable reels, or cable wrenches.

G. Labeling. The Contractor shall be responsible for printed labels for all cables and cords, distribution frames, and outlet locations, according to Owner specifications. No labels are to be written by hand.

H. Cable Storage. The Contractor shall not roll or store cable reels without an appropriate underlay and the prior approval of the Owner.

I. Damages. The Contractor will be held responsible for any and all damages to portions of the building caused by it, its employees or subcontractors; including but not limited to:

1. Damage to any portion of the building caused by the movement of tools, materials or equipment.
2. Damage to any component of the construction of spaces “turned over” to the Contractor.
3. Damage to the electrical distribution system and/or space “turned over” to the Contractor.
4. Damage to the electrical, mechanical and/or life safety or other systems caused by inappropriate operation or connections made by the Contractor or other actions of Contractor.

J. Penetrations of Walls, Floors, and Ceilings. The Contractor shall make no penetration of existing walls, floors and/or ceilings without the prior consent of the Owner. Where penetrations through acoustical walls, fire-rated doors or other walls for cableways are to be installed, such penetrations shall be sealed by the Contractor in compliance with applicable code requirements.

K. The CTC’s and all components of the system shall be installed in a neat, workmanlike manner. Wiring color codes shall be strictly observed, and terminations shall be uniform throughout the system. Identification markings and systems shall be uniform. TIA/EIA 568B wiring codes as shown on the drawings shall standardize all SCS wiring. The CTC shall be level and plumb.

L. All structured wiring shall be neatly routed, protected, and tied down. Install Velcro wrap on all cable bundles within the network rack/enclosure. All cabinets shall be cleaned out. All spare parts and documentation shall be turned into the Owner.

M. At the completion of the SCS, the Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract. All clean up, restoration, and removal noted above will be by the Contractor and at no cost to the Owner. If the Contractor fails in its duties under this paragraph, the Owner may upon notice to the Contractor perform the necessary clean up and deduct the costs thereof from any amounts due or to become due to the Contractor.

3.2 NETWORK PROGRAMMING AND COMMISSIONING

A. Programming and Commissioning of the Network shall be by SKM.

3.3 TESTING

A. Optical Fiber Cable Testing

1. All fiber testing shall be performed on all fibers in the completed end to end system. There shall be no splices unless approved in writing by the Engineer. Testing shall consist of a bidirectional end to end OTDR trace performed per EIA/TIA 455-61. All tests shall be conducted using 200ft launch cables. The system loss measurements shall be provided at 850 and 1310 nanometers for multimode fibers and 1310nm and 1550 nm for singlemode fibers.
2. The Contractor shall test all fiber optic cable prior to the installation of the cable. The Contractor shall assume all liability for the replacement of the cable should it be found defective at a later date.
3. Loss Budget: Fiber links shall have a maximum loss of:
   a. (3.0 dB loss/km)*(km of fiber in link) + (0.5dB) * (number of connectors)

b. Note that a mated connector to connector interface is defined as a single connector for the loss calculation.
c. Any link not meeting the requirements of the standard shall be brought into compliance by the Contractor, at no charge to the Owner.

4. Documentation of all fiber optic cabling tests shall be provided in both hard and electronic copies to the Engineer.

B. Copper cable testing

1. Testing of all copper wiring shall be performed prior to system commissioning. All Ethernet cabling shall be certified for conformance to EIA/TIA 568B for Category 6. Testing shall be done with a TIA/EIA Certified Level 3 test set. Test shall include length, mutual capacitance, characteristic impedance, attenuation, near-end and far-end crosstalk. Any pairs not meeting the requirements of the standard shall be brought into compliance by the Contractor at no charge to the Owner.
2. Documentation of all copper cabling tests shall be provided in both hard and electronic copies to the Engineer.

3.4 FIELD QUALITY CONTROL

A. On-going inspections shall be performed during construction by the Contractor and by the Engineer to ensure that all work is performed in a high-quality manner and the overall appearance is clean, neat and orderly. The following points will be examined and must be satisfactorily complied with:

1. Is the design documentation complete? Are all cables properly labeled, from end-to-end?
2. Have all terminated cables been properly tested in accordance with the specifications for the specific category as well as tested for opens, shorts, polarity reversals, transposition and presence of AC and/or DC voltage?
3. Is the cable type suitable for its pathway? Are the cables bundled in parallel?
4. Have the pathway manufacturer's guidelines been followed? Are all cable penetrations installed properly and fire stopped according to code?
5. Has excessive cable bending been avoided?
6. Have potential EMI and RFI sources been considered?
7. Is Cable fill correct?
8. Are hanging supports within 1.5 meters (5 feet)?
9. Does hanging cable exhibit some sag?
10. Are telecommunications closet terminations compatible with applications equipment?
11. Have Patch Panel instructions been followed?
12. Are identification markings uniform, permanent and readable?

END OF SECTION 409533

SECTION 409600 – PROCESS CONTROL SOFTWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PLC Programming Software
2. OIT Programming Software
3. SCADA System Software

B. Related Sections:

1. Refer to Section “409443 Programmable Logic Controllers” for PLC Hardware requirements.
2. Refer to Section “409433 Human Machine Interfaces” for OIT and SCADA System requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Software to be furnished under this section shall be the product of firms regularly engaged in the design and manufacturing of this type of equipment.

B. Examine the Contract Documents and verify that Software being provided is compatible with the requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the Software to the Owner prior to startup and commissioning.

PART 2 - PRODUCTS

2.1 PLC PROGRAMMING SOFTWARE

A. PLC Programming Software shall be provided by SKM.

2.2 OIT PROGRAMMING SOFTWARE

A. OIT Programming Software shall be provided by SKM.

2.3 SCADA SYSTEM SOFTWARE

A. SCADA System Software shall be provided by SKM.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with the Owner the installation of all software on PC's. Insure that each software package is compatible with the PC's operating system.

B. Refer to the requirements of Sections 409000 and 409443 as well as the Contract Drawings.

3.2 TRAINING

A. Refer to the requirements of Section 409000.

END OF SECTION 409600

SECTION 409635 – PROCESS CONTROL SOFTWARE PROGRAMMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PLC Programming Requirements
2. OIT Programming Requirements
3. SCADA System Programming Requirements

B. Related Sections:

1. Refer to Section “409443 Programmable Logic Controllers” for PLC Hardware requirements.
2. Refer to Section “409433 Human Machine Interfaces” for OIT and SCADA System requirements.
3. Refer to Section “409600 Process Control Software” for software requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Programming to be furnished under this section shall be the product of firms regularly engaged in the programming of this type of control system.

B. Examine the Contract Documents and verify that programming being provided is compatible with the requirements.

PART 2 - PRODUCTS

2.1 PLC PROGRAMMING REQUIREMENTS

A. PLC Programming shall be provided by SKM.

2.2 OIT PROGRAMMING REQUIREMENTS

A. OIT Programming shall be provided by SKM.

2.3 SCADA SYSTEM PROGRAMMING REQUIREMENTS

A. SCADA System Programming shall be provided by SKM.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to the requirements of Sections 409000 and 409443 as well as the Contract Drawings.

3.2 TRAINING

A. Refer to the requirements of Section 409000.

END OF SECTION 409635

SECTION 411436 – IBC TOTE SCALE

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Supply and install IBC tote scales and remote indicators as shown on the drawings.

1.2 SUBMITTALS

A. Submit manufacturer's installation instructions and procedures and manufacturer's product data including dimensional drawings and wiring diagrams and warranty information.

PART 2 - PRODUCTS

2.1 IBC TOTE SCALES

A. The IBC tote scale shall have the capacity of minimum 3,000 lbs. The IBC tote scale shall be sized to accept a 48 inch by 40 inch tote scale.

B. The Spill Containment IBC Tote Scale must have rugged steel frame that is zinc oxide primed and dry powder epoxy coated and shall be resistant to moisture, chemicals, abrasion, impact and UV. The integral containment deck and basin shall be solid polyethylene. All hardware must be stainless steel. Scale frame height shall not exceed 5.65". Total height with containment deck shall not exceed 30.0". Scale must have four (4) NTEP stainless steel shear beam load cells with stainless steel leveling feet. Load cells shall be located outside the chemical containment basin to eliminate damage due to chemical spills.

C. A flexible cable shall connect the load cells to the indicator to allow for easy remote installation of the readout. Cable length shall be as shown in the plans and not less than 30 feet.

2.2 INDICATOR

A. Indicator must be electronic with a two line, backlit alphanumeric digital display with characters 0.56 inches high and housed in a NEMA 4X, UL approved enclosure. Available as single or dual channel and capable of displaying two channels simultaneously. A loop powered programmable output of 4-20 mA and two set points per channel must be standard equipment. Indicator must be capable of 0.1 lb. or 0.1 kg up to 9999.0 lbs. or kg. Accuracy is 0.5% of full scale, or better.

2.3 WARRANTY

A. The scale shall carry a full five-year factory warranty.

2.4 MANUFACTURERS

A. Model 4042-63 IBC as manufactured by Scaletron Industries Ltd.

B. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the scales and the indicators according to the manufacturer’s installation instructions and recommendations.

B. The Contractor shall provide the services of authorized equipment supplier's representatives to conduct all field tests for a minimum of one (1) day and one (1) trip.

END OF SECTION 411436

SECTION 412100 – SHAFTLESS SCREW CONVEYOR

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the supply and delivery of four (4) shaftless screw conveyors for the conveyance of dewatered sludge from two screw presses

1.2 GENERAL

A. Equipment furnished in this specification shall be fabricated and assembled in full conformity with this specification and as shown in the contract drawings. Each conveyor shall be furnished complete with all supports; all mechanical equipment required for proper operation, including complete drive units; all steel, iron, and other metal construction specified herein; and all additional materials or fabrication as required by the supplier's design.

B. The drawings showing the screw conveyor equipment are general in nature and are not intended to show all and exact details. The Supplier shall work closely with the Contractor to resolve details of the installation. Contractor and supplier shall coordinate design and final location of conveyor inlet and discharge chutes.

C. All equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and the satisfactory operation of the system.

1.3 PERFORMACE REQUIREMENTS

A. Design the shaftless screw conveyor system to meet the performance and design requirements per Section 4.0 Conveyor selection design standards to be based on the operational experience of the manufacturer with shaftless screw conveyors, and not shafted screw conveyors.

B. Conveyor rotational speeds shall not be greater than herein specified, unless availability of the reducer ratio requires slight adjustment (+/- 3 rpm) or if shown by the conveyor manufacturer calculations to be required to meet design load. Deviations from specified speed cannot be utilized to reduce the conveyor trough and spiral size. Slower speeds are utilized to prevent the fluidization or apparent thinning when conveying dewatered sludge, to reduce liner and spiral wear from abrasive material.

C. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUBMITTALS

A. The equipment Supplier shall, as a minimum, submit the following information for review and approval by the Engineer:
   1. Descriptive literature regarding the conveying equipment to be supplied.
   2. Reference information and certifications as required.
   3. Detailed specifications for the Equipment proposed. Manufacturer's certification, signed by a corporate officer, confirming that the proposed Equipment fully complies with these specifications.
   4. A copy of this specification section with any addendum updates shall be included in the submittal. Mark each paragraph with either a check mark to indicate compliance with the specification or an "X" to indicate deviation. If a deviation from the specification is indicated, and therefore requested by the Contractor, the submittal shall be accompanied by a detailed, written justification/explanation for each deviation. Failure to include a copy of the marked-up specification section along with justification for any requested deviation to the specification requirements with the submittal shall be cause rejection of the entire submittal with no further consideration.
   5. General arrangement drawing(s) for the proposed Equipment. An electronic copy (Revit or STP CAD file) of the arrangement drawings shall also be made available.
   6. Cut sheets for electric motors and ancillary items manufactured by others not limited to manual and actuated gates.
   7. Conveyor torque requirement calculations.
   8. Torque calculations for the gear reducer and reducer motor.
   9. Horsepower calculations for the drive motor(s).
   10. Utilize spiral strength calculations for spring (spiral) compression and elongation showing the supplied spiral meets or exceeds spring effect intent of 2.6 herein. Complete schematic diagrams for electrical control panel(s) if applicable.
   11. Equipment weights and lifting points.
   12. Operations & Maintenance Manual (generic sample with submittal, complete and site-specific O&M six weeks from submittal approval).
   13. Structural support and anchor bolt design and calculations stamped by a professional engineer registered in the State of Utah.
   14. Design loadings to be transmitted to foundations or supports.

B. The contractor is responsible for coordination of all mechanical & electrical equipment, and structural interconnecting or otherwise interfacing with the conveyor and any site measurements required for a detailed conveyor submittal. If a Contractor requests a conveyor submittal prior to furnishing all the required data to complete full and precise general arrangement drawings, the Contractor shall bear the cost of re-submittal and drawing revisions to the equipment manufacturer.

1.5 QUALITY ASSURANCE

A. Fabricate and assemble all equipment under this section in full conformity with this specification and as shown in the contract drawings.

B. Furnish equipment complete with all supports; all mechanical equipment required for proper operation, including complete drive units; all steel and other metal construction specified herein; and all additional materials or fabrication as required by the supplier's design.

C. Unless otherwise noted all equipment included in this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and the satisfactory operation of the system.

D. Provide evidence of at least fifteen (15) years demonstrable experience in the design and manufacture of shaftless conveyor systems. The Supplier shall have at least twenty-five (25) full-scale shaftless conveyor systems operating successfully for at least five (5) years in North America at municipal wastewater treatment plants that were designed and furnished under the Supplier's own name.

1.6 WARRANTY

A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twelve (12) months after the equipment was first placed into operation at the jobsite or eighteen (18) months after the equipment was first delivered to site, whichever date occurs first. Any warranted material defects found to exist shall be corrected (repaired or replaced) at no cost to the Owner.

B. The shaftless screw liner and spiral for the dewatered sludge shall be warranted for a period of three years from factory start-up against wear.

C. Liner: For a wear indicator (two color) liner, excessive wear shall be indicated by appearance of the bottom indicator layer (second color) along more than 30% of the conveyor length during the first three years of service (one year of service for dried sludge conveyors). If these wear indications occur the conveyor supplier shall provide new formed and banded liner to replace all the liner in the conveyor that has excessive wear.

1. Screw: Excessive wear on the screw shall be indicated by loss of more than 50% of the height of the main outer screw section over 30% of the total length of the screw. If excessive screw wear is found the conveyor supplier shall provide new screw to replace the screw in the conveyor that has excessive wear.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The shaftless screw conveyors shall be manufactured by a supplier with not less than 60 operating installations of shaftless screw conveyors in North America. The Contractor shall provide the Engineer with a written statement indicating that the conveyor manufacturer has at least 15 years experience in the construction and manufacture of shaftless conveyor systems incorporating the design features as herein specified. Manufacturer must have at least 10 conveyors in operation over 40 ft long.

B. The Supplier shall acknowledge that he is familiar with all the requirements of the contract documents relevant to the equipment supplied herein and agrees to perform and observe all

obligations under the contract documents which relates to the portion of the work covered by this section and related sections.

C. The system shall be of the shaftless type as manufactured by:

1. JDV Equipment Corporation, Dover, New Jersey
2. Jim Myers & Sons
3. SPIRAC
4. Or Equal

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. The shaftless screw conveyor system shall be designed to meet the following minimum performance and design requirements. The standards for conveyor selection shall be based on the operational experience of the manufacturer with shaftless screw conveyors, and not standards developed for shafted screw conveyors.

POSITION	CONVEYOR #1 (ME-80510)	CONVEYOR #2 (ME-80515)	CONVEYOR #3 (ME-80517)	CONVEYOR #4 (ME-80520)
Cubic ft per Hour	100	100	100	100
Material	Sludge	Sludge	Sludge	Sludge
Material Density	65	65	65	65
Min Solids	18%	18%	18%	18%
Length	22ft	16ft	22ft	35ft
Angle	Horizontal	Vertical	Horizontal	Horizontal
Max Screw Speed RPM	20	40	20	20
Max Trough Fill	50%	100%	50%	50%
Min Flight OD	9in	9in	9in	9in
Min Spiral Weight per ft.	19.6lb	19.6lb	19.6lb	19.6lb
Minimum Trough Width	10in	10in	10in	10in
Minimum HP	3	5	3	3
Drive Location	Inlet	Discharge	Inlet	Inlet
Motor Type	TEFC	TEFC	TEFC	TEFC
Reversing Screw	None	None	None	Yes

2.3 MATERIALS

A. Unless otherwise specified or permitted, the materials used in the fabrication of the equipment under this section shall conform to the following:

1.	Chutes	AISI 316, ASTM A167, 18-8
2.	Troughs, End Plates, Covers	AISI 316, ASTM A167, 18-8
3.	Supports	AISI 316, ASTM A167, 18-8
4.	Hoppers	AISI 316, ASTM A167, 18-8
5.	Spiral Flighting	Cold formed, High Strength Micro Alloy Carbon Steel with aminimum hardness of 220 Brinell
6.	Wear Liner	Ultrahigh molecular weight polyethylene sintered with antiwear filler and synthetic lubricants(4.02.04A)
7.	Bolts, Nuts, and Washers for Conveyor Supports	AISI 316, ASTM A167, 18-8
8.	For Conveyor Trough, Lids, and Drive	AISI 304, ASTM A167, 18-8

2.4 FABRICATION

A. The shaftless screw conveyor equipment shall include the following:
   1. Troughs, Liners & Covers
   2. Spiral Flighting
   3. Chutes
   4. Covers
   5. End Shaft
   6. End Seals
   7. Electric Motor & Gear Reducer
   8. Mounting and Support Structure
   9. Slide Gates
   10. Electrical Control Panel
   11. Safety Accessories
   12. Spare Parts

B. All welds to be continuous unless otherwise specified. Facing surfaces of bolted joints shall be shop primed. Facing surfaces of field-welded components shall be beveled and match marked. All shop welds shall conform to the latest standards of the American Welding Society (AWS).

C. Sharp corners of all cut and sheared edges shall be made smooth by edge grinding.

2.5 POWER SUPPLY

A. Power Supply to the equipment will be 480 volts, 60 Hz, 3 phase. Power supply for controls shall be 120 volts, 60 Hz, single phase.

2.6 SURFACE PREPARATION

A. Fabrication - All welds shall be continuous unless otherwise specified. Facing surfaces of bolted joints shall be shop primed. Facing surfaces of field welded components shall be beveled and match marked.

B. Edge Grinding - Sharp corners of all cut and sheared edges shall be made smooth by a power grinder.

C. Fasteners - All bolts, nuts, washers, and other fasteners shall be AISI 316 stainless steel.

D. Surface Preparation - All iron and mild steel surfaces to be painted shall be dry abrasive grit blasted to "near white metal" in accordance with SSPC-SP6 or SSPC-SP10, and in accordance with the painting section of these specifications. Grit blasted surfaces shall be painted within 24 hours to prevent rusting and surface discoloration.

E. Painting - After surface preparation, metal surfaces except for the spiral flighting shall receive a minimum of one coat of primer or equal for the spiral, and for other surfaces one primer and one coat epoxy paint prior to shipment to jobsite.

2.7 SPIRAL FLIGHTING

A. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft. The minimum overall spiral weight and surface pressure shall be as specified herein. The conveyor will include an inner flight to increase axial strength and capacity of the conveyor. The minimum spiral weight shall be specified herein.

B. Spiral flights shall be cold-formed high strength micro alloy steel with a minimum hardness of 220 Brinell. The spiral flights shall be designed with the stability to prevent distortion and jumping in the trough. The torsional rating of the auger flighting shall be reached at 30% of the Fy value in the extreme fiber of the flight material. Supplier shall demonstrate that, at 250% of the motor nameplate horsepower, the drive unit cannot produce more torque than the torsional rating of the flighting, and that the "spring effect" of the spiral shall not exceed + 0.8 mm per meter of length at maximum load conditions.

C. Spiral flight material, fabrication technique, strength, hardness, and overall quality are critical to the proper operation of the conveying system as herein designed. Spiral flights that do not meet the characteristics or herein specified are specifically not acceptable. Supplier shall provide certified written documentation that the spiral flights conform to the following:
   1. Material: Micro Alloy Steel
   2. Hardness: 220 Brinell Minimum
   3. Concentricity: 2.0 mm +/-

D. Supplier shall maintain a certified factory quality control program which shall include certification of spiral flighting as described herein.

E. The spiral flighting shall be formed in sections from one continuous flat bar and shall be concentric to within 2mm +/-. Sectional flighting formed from plate shall not be permitted.

F. Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled in the field and shall be made in accordance with the supplier's requirements. The spiral flights shall be coupled to the end shaft by a flanged, bolted connection.

G. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating flange and shall be bolted to the spiral connection plate.

2.8 HORIZONTAL AND INCLINED THROUGHS

A. Troughs shall be similar to the dimensional standards of CEMA 300 and enclosure classification IIE. Each conveyor trough shall be U-shaped, fabricated from a minimum 1/8 inch stainless steel plate.

B. Stiffeners shall be placed across the top of the trough and fastened to both sides of the trough to maintain trough shape and act as a face seal for the covers; apply a continuous gasket, one half inch width, to the entire top face of the trough top flange and stiffeners. Welded in stiffeners/cross braces shall not be allowed.

C. Each trough shall be equipped with filling and/or discharge openings as required by the contract drawings. If required, each filling and discharge opening shall be flanged suitable for interconnection to other devices. Any interconnecting devices such as chutes and hoppers shall be fabricated from the same material as the troughs.

D. A flanged covered drain or threaded outlet (with SS isolation valve) shall be provided with each conveyor to facilitate cleaning.

E. The portion of each trough that is not covered by the filling chute shall be covered by a bolted cover of a material identical to the trough. The covers shall be manufactured in maximum five foot length section to allow for access to the conveyors. To prevent unsafe access to the conveyors, quick opening covers will not be allowed.

2.9 VERTICAL TROUGHS

A. Vertical trough conveyors shall be provided where indicated on the contract drawings. Vertical troughs shall be of segmented construction to allow ready access to the conveyor internal for inspection, service, and cleaning. The trough shall be specifically constructed to prevent "wobble" and/or binding of the spiral during normal operation. Construction must allow free movement of the spiral, to prevent jamming or stalling. Maximum rotational speed shall not exceed 40 RPM and designed to prevent excessive vibration and dynamic imbalance. To prevent premature failure of vertical shaft seal, packing type seals will not be acceptable. A pneumatic or grease type compression seal with continual relief shall be supplied. If plant air is available, the contactor shall be responsible for hard piping the pneumatic lines to the seal. The seal shall rely on pressure to continually relieve air or grease toward the inside of the conveyor to prevent debris from wearing or scoring the drive shaft and seal. Two drains shall be supplied, one for draining the other for cleaning. In addition, a manually operated flushing connection shall be supplied in the drain area to breakup and clean accumulated debris.

2.10 WEAR LINERS (UHMW)

A. The wear liner for each conveyor shall be fabricated of ultra-high molecular weight polyethylene sintered with an anti-wear filler to reduce wear and synthetic lubricant to reduce friction. The liner shall be provided with a visual (two different color) indicator of excessive wear. The wear liner shall be furnished in maximum four-foot sections, 3/8” minimum thickness, to provide ease of replacement. The liner shall be held in place with clips; no fasteners will be allowed.

2.11 INLET AND DISCHARGE CHUTES

A. Inlet and discharge chutes shall be provided by the conveyor supplier as shown on the drawings. All chutes shall be fabricated from the same material as the conveyor trough.

B. At a minimum chutes and conveyor openings shall be as long as 1.5 times the screw pitch shall be the full width of the conveyor trough.

C. Where indicated in drawings, furnish single-ply flanged discharge boots. The flexible boots shall be EPDM or Neoprene.

2.12 CONVEYOR SUPPORT

A. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the contract drawings and as required by the supplier's design. The supports shall be shop fabricated from structural steel shapes and plates and shall be assembled and fitted to the conveyor prior to its delivery to the jobsite. Supports and conveyor segments shall be match marked and shipped to the jobsite for assembly by the contractor or others. At a minimum, each conveyor shall be provided with supports at the inlet and discharge end, with intermediate supports as required.

B. Supports shall be fabricated of AISI 304 stainless steel or equal.

C. All shop welding shall conform to the latest standards of the American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or equipment supports.

D. Contractor shall be responsible to coordinate the support lengths and locations with the contractor and Double Tee or Steel Web Truss supplier.

2.13 STRUCTURAL DESIGN

A. All structural supporting members shall be designed such that the ratio of the unbraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (of angles about Z-Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed the American Institute of Steel Construction allowable stresses by more than 1/3 when subject to loading of twice the maximum design operating torque of the spiral conveyor drive motors.

2.14 DRIVE UNITS

A. Each spiral conveyor shall be driven by a constant-speed integral gear reducer/motor drive unit mounted to an adapter flange mounted to the end plate of the conveyor. The adapter flange shall allow the leakage of any material from the conveyor trough to atmosphere rather than into the gear reducer/ motor drive unit. Direct coupling of the gear reducer/motor drive unit to the end flange of the conveyor will not be acceptable.

B. The drive unit shall be rigidly supported so there is no visible "wobble" movement under any operating condition. In the event of a prolonged power failure or emergency system shutdown the drive system shall be designed, at a minimum, to start the conveyor from a dead stop with the trough filled throughout its entire cross-sectional area and length with partially dried and hardened dewatered material.

C. Each motor shall be 460 volt, 60 Hz, 3 phase conforming to the General Equipment specifications, except as modified herein. Each motor shall be high efficiency, 40C ambient rated, 1.15 service factor and shall have Class F insulation. Motor shall have a TEFC enclosure with Design B speed/torque characteristics.

D. Drive unit for conveyor ME-80520 shall be reversible.

2.15 GEAR REDUCER

A. All gears shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the fully loaded startup condition and shall have an AFBMA B-10 life of 30,000 hours.

B. The reducer will be air-cooled unit with no auxiliary cooling requirement. The gear reducer shall be sized with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate, at the driven shaft speed, whichever is greater.

2.16 GLAND PACKING

A. An adjustable greased gland packing ring consisting of two Teflon coated packing rings shall seal the drive shaft at its penetration through the end plate.

2.17 MOTION FAILURE ALARM UNIT

A. Each conveyor drive unit shall be equipped with a motion failure alarm unit. Unless noted otherwise, the location and mounting details shall be as recommended by the conveyor manufacturer. Motion sensors shall be the non-contacting type using a probe with a pre-amplifier and main electronic assembly. The main electronic unit shall operate on 120 volt, single phase, 60 Hz power supply, and shall be housed in a NEMA 4X enclosure. A 0 to 60 second time delay shall be provided for startup of the conveyor.

2.18 EMERGENCY SHUTDOWN

A. Each conveyor shall be furnished with an emergency trip cord and safety switch. The cord shall run the full length of each conveyor. The trip switch shall immediately stop all conveyors when the switch is actuated. Switch shall be double acting if cord is pulled or cut, except for explosion proof applications.

2.19 SLIDE GATES

A. The conveyor system shall include slide gates at locations shown on the drawings. Each slide gate shall be electro mechanically operated. The slide gates shall be specifically designed to operate as an integral part of the conveyor system, and shall be supplied by the conveyor manufacturer.

B. ELECTRO-MECHANICALLY OPERATED SLIDE GATES: The slide gates shall be designed with a maximum vertical dimension of 6", excluding the electric motor operator. The slide gate shall be designed so that in the full, open position at least 1.5 rotation of the spiral is exposed to the opening in the direction of transport. The slide gates shall have an opening at least the full width of the conveyor. Minimum opening size shall be 14"L x 10"W. The slide gates shall be fabricated entirely of AISI 304 stainless steel and suitable non-metallic components, all minimum 3/16" thickness. The conveyor manufacturer shall provide electric motor operated gate operator, Rotork IQ, Limitorque MX, or equal.

2.20 ELECTRICAL EQUIPMENT

A. All electrical equipment shall conform to applicable standard of the National Electrical Manufactures Association (NEMA) and the National Electrical Code (NEC). Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.

B. All motors shall be totally enclosed, fan cooled (TEFC). Control panels shall be NEMA 4X, stainless steel.

2.21 ELECTRICAL CONTROLS

A. Each shaftless conveyor shall be provided with an electrical control panel as described below and designed in strict accordance with Electrical Sections of these specifications.

B. Control Panel
   1. Control panel shall be of the wall-mounted or free-standing type with NEMA ¬4X enclosure.
   2. Each control panel shall include a motor starter, run, stop and fault indicator lights, elapsed time meter, main disconnect switch, Hand-Off-Auto selector switch, emergency "STOP" button and electric motor power monitor.
   3. Each control panel shall be equipped with a HAND-OFF-AUTO selector switch. Control panels for ME-80520 shall be equipped with a HAND-OFF-AUTO-REVERSE JOG selector switch.
   4. In the HAND position, the conveyor shall start.
   5. In the AUTO position;
      a. The conveyor shall start whenever the equipment that supplies material to the conveyor is energized.
      b. The conveyor drive shall stop automatically upon failure of the conveyor as indicated by its motion failure alarm unit, upon the failure of any downstream conveyor (if applicable), upon tripping / activation of the emergency stop switch, or upon electric motor overload.
   6. In the OFF position, the conveyor shall stop.
      a. The controls shall include an adjustable 0 – 30 minute timer that will allow a purge cycle, then automatically shut off the conveyor(s) after the equipment that supplies the conveyed material stops.
   7. The REVERSE JOG position shall be a momentary control. The conveyor shall run in reverse only so long as the operator is operating the switch.

2.22 LID PRESSURE RELIEF

A. The conveyor shall be supplied with pressure relief assembly in which the conveyor will automatically shut down if excessive material builds up in the conveyor to prevent damage to the conveyor shaft or lid. This is to be accomplished with a limit switch reacting to movement in a section of the lid which is hinged to allow movement as material builds up beneath. The pressure relief assembly shall be strategically located based on the conveyor manufacturer recommendations. Supplier shall submit to Engineer any alternate system for approval.

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE

A. Conveyors shall be inspected and operated in the shop with the actual drive unit for this project in its entire length. Conveyor longer then the required shipping lengths will have the screws tack welded together and tested in their entire length. Conveyors should be operated for a minimum of 15 minutes and observed for alignment and abnormal operation. Conveyors shall be corrected as necessary. Prior to shipment the tack welds will be broken apart and conveyors suitably prepared for shipment. A video of the test should be supplied on disk to the contractor to be forwarded on to the engineer for record purposes. Video must be received to get paid.

3.2 SPARE PARTS

A. Furnish the following spare parts as a minimum;
   1. One (1) Packing gland set, for each conveyor supplied
   2. One (1) gate UHMW seals, set for each size/type gate supplied
   3. One (1) Spare light bulbs and fuses of each size used in the electrical control panels
   4. One (1) complete set of liners for all conveyors.

B. All spare parts except electrical shall be boxed in substantial wooden crates for storage.

3.3 LUBRICANTS

A. Furnish lubricants of the type and quantity as recommended by the conveyor manufacturer for (start-up) operation.

3.4 FIELD SERVICES

A. After the equipment is installed the supplier shall provide a factory trained, experienced, competent, and authorized representative of the supplier to the jobsite to inspect, check, and approve the equipment installation supervise initial operation, and to train operating personnel in the proper operation and maintenance of the system. These services shall be performed by the supplier's representative at the jobsite for a minimum three (3) eight (8) hour days (not necessarily consecutive) when the equipment is placed in service.

B. The equipment manufacturer’s inspection of the equipment following installation by others, and to certify that the equipment has been properly installed and is ready to operate, to train the Owner’s personnel in the operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment.

C. Field services at the jobsite shall be performed during normal daylight working hours from Monday – Friday; legal holidays accepted. The Supplier’s personnel shall not be expected to work overtime.

D. The Contractor shall coordinate the manufacturer's technical services in a timely professional manner. At a minimum, two weeks' notice must be given to the manufacturer for travel planning purposes unless previously agreed by the manufacturer. To avoid project delays, every effort should be made to coordinate inspection, training and startup of the equipment in one trip. If the manufacturer is asked to make trips in excess to the stated contract document requirements due to lack of coordination, planning or efforts of the contractor, then the contractor is responsible for additional costs incurred by the manufacturer.

E. After inspection of the installed equipment the Supplier shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchorage, has been operated under full load conditions and that it operates satisfactorily.

END OF SECTION 221426

SECTION 412223 – CRANE AND MONORAIL SYSTEMS

PART 1- GENERAL

1.1 SUMMARY

A. Section Includes: The work required under this section shall include the designing, manufacturing, shipping, installing and field testing of a monorail system with electrical hoist with a motorized trolley.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME)
   1. B30.11 for Underhung Cranes and Monorail Systems.
   2. B30.16 for Overhead Hoists

B. Occupational Safety and Health Administration (OSHA)
   1. Par. 1910.179 Overhead & Gantry Cranes

C. ASTM International (ASTM)
   1. A992, Standard Structural Steel Beams

D. American Institute of Steel Construction (AISC)
   1. Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings

E. American Welding Society (AWS)
   1. D1.1 - Structural Welding Code - Steel
   2. D14.1 - Overhead Cranes

1.3 DEFINITIONS

A. Hook Height: The minimum acceptable distance in feet from bottom of hook in full raised position to the nearest floor surface.

B. Lift Height: The distance in feet from the bottom of the hook in full raised position to the surface of the lowest floor from which items may be hoisted.

C. Total Trolley Capacity: The ultimate load-carrying capacity of the trolley based on the ultimate strength of the material used (with a 5:1 safety factor) and the bearing life.

D. Ultimate Load-Carrying Capacity: Live load, weights of all equipment and an allowance for impact.

1.4 OPERATING SPECIFICATIONS

A. Monorail System #1 – Headworks Pump Station.

Quantity:	1 monorail, 1 hoist
Capacity:	5 ton, each hoist

Monorail Beam:	A-992 Hot Rolled Steel or Enclosed Track
Support Steel:	A-992 Hot Rolled Steel
Monorail Beam Deflection:	L/450, not to exceed 1 ½ inches
Hoist:	Electric Wire Rope Hoist
Lift:	30'-0" minimum
Trolley:	Motorized Trolley
Bumpers:	Rubber

B. Monorail System #2 – Dewatering Building.

Quantity:	1 monorail**,** 1 hoist
Capacity:	5 ton, each hoist
Monorail Beam:	A-992 Hot Rolled Steel or Enclosed Track
Support Steel:	A-992 Hot Rolled Steel
Monorail Beam Deflection:	L/450, not to exceed 1 ½ inches
Hoist:	Electric Wire Rope Hoist (Class 1 Div 2)
Lift:	15'-0" minimum
Trolley:	Motorized trolley
Bumpers:	Rubber
Hazardous Classification:	Class 1, Division 2

1.5 SUBMITTALS

A. Shop Drawings
1. See Specification Section 013300 for requirements for the mechanics and administration of the submittal process.
2. Submit for approval, Shop Drawings showing complete details, dimensions, field coordinates and bills of material for fabrication and erection.
3. Include member sizes, model numbers, specifications, reactions and complete shop and field notes such as welding symbols, paint requirements, bolt sizes, etc.
4. Submit complete calculations for member sizes, design criteria and seismic calculations stamped by a licensed PE in the State of Utah.

B. Product Data
1. Provide information on all components, sub-assemblies, mechanical features, etc. relating to the equipment supplied under this specification.
2. Include brochures, catalog cuts, parts breakdowns, operation and maintenance manuals, clearance diagrams, dimensional data (not supplied in the shop drawings) and any other data necessary for the engineer to determine compliance with specifications.

1.6 QUALITY ASSURANCE

A. Suppliers shall have documented experience of ten (10) years, having successfully designed and built installations of similar scope.

B. Suppliers shall be responsible for providing equipment of highest quality and workmanship which will perform specific functions reliably and safely and allow required maintenance procedures with a minimum amount of interference to operation

of the equipment.

C. Any exceptions to this specification must be approved by the engineer of record.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers
1. American Equipment Systems, LLC
2. Detroit Hoist
3. Yale
4. R&M
5. Or equal

2.2 WIRE ROPE HOIST

A. Hoist Motor and Braking System
1. Hoist motor shall develop sufficient power to lift the rated load at the specified speed.
3. The hoist shall have a disc type motor brake. Brake material shall not contain asbestos.

B. Hoist Gearing
1. Hoist gearing shall be helical, heat treated alloy steel and shall operate in an oil bath.

C. Hoist Drum and Rope
1. The rope drum shall be welded steel construction, deep grooved and precision machined to give maximum rope life. Drum shall be supported at each end by sealed anti-friction bearings.
2. The hoisting rope shall be of a proper design and construction for hoist service. The rated capacity load divided by the number of parts of rope shall not exceed 20% of the breaking strength of the rope.
3. Double wrapping of the rope shall not be permitted. A drum rope guide shall be provided. A minimum of two wraps shall remain on the drum with the hook in the lowest position.
4. Bottom block shall have a totally enclosed housing fabricated of steel. The rope sheaves shall be supported on an anti-friction thrust bearing. Hook shall be a single barbed type hook ~~as supplied by Crosby~~ and shall be equipped with a heavy spring safety latch.
5. Hoist shall be equipped with upper and lower limit switches as well as a redundant block operated upper limit switch. The switches shall be adjustable to set the extreme upper and lower limits of hook travel.
6. Hoist shall be equipped with an overload device to prevent lifting loads in excess of 125%.

2.4 MONORAIL BEAMS

A. Hot Rolled Shapes
1. Monorail beams shall be designed to meet the requirements of this specification and good structural design practice. Beams, bracing, end stops, and electrification brackets (if required) shall be supplied by the monorail supplier

B. Structural Supports

1. All necessary columns, beams, frames and bracing shall be supplied by the monorail supplier.
2. Design shall be in accordance with AISC and good structural practice.

2.4 PAINTING

A. Structural Steel
1. All structural steel shall be cleaned of rust and mill scale with a minimum SSPC SP3 “power tool” cleaning.
2. Structural steel shall be painted with 1 coat industrial primer and 1 coat industrial enamel.

B. Hoist
1. Hoists shall be painted per the Hoist manufacturer’s standard coating.
2. Hooks shall not be painted

C. Monorail Beams
1. Monorail beams shall be painted per the Manufacturer’s standard coating.
2. Aluminum beams need not be painted.

2.5 MISCELLANEOUS

A. Quality and Spare Parts
1. To properly serve the crane user’s needs of after sales service and spare parts, the manufacturer shall have local availability of service and spare parts.

B. Factory Testing
1. Following complete assembly of the hoist in the factory, all components shall be tested to insure correct operation.
2. Push-buttons shall be tested for operation of each movement.
3. All motors shall be phased correctly in the factory and on-site for proper operation.

2.6 INTERCHANGEABILITY

A. Provide like parts on components furnished which are interchangeable and give particular attention to items that may require replacement or adjustment during the life of the crane.

2.7 SAFETY DEVICES

A. Each hoist will be provided with all safety devices required by federal, state or local law.

B. Each hoist will be provided with a capacity plate with 3 inch high letters on each side of the hoist giving the capacity in tons.

C. System shall be supplied with a readily accessible power disconnect on the wall adjacent to the operating area provided by the electrician.

2.8 MATERIALS

A. All materials shall be new and meet the requirements of the applicable codes mentioned in this specification. All load bearing parts shall have a 5:1 factor of safety.

B. Structural steel used in the fabrication of support steel shall be new and meet the minimum ASTM standards.

2.9 SHIPPING

A. After factory tests are completed, disassemble the crane into major components for shipment with all major points of attachment match-marked to facilitate final assembly, and all exposed finished parts coated with compound before shipment. Properly pack all small parts in boxes with parts identification clearly marked on the outside of each box.

B. Supplier shall replace all parts of the system that are damaged or lost in shipment without cost to the Owner.

PART 3 -EXECUTION

3. 1 SYSTEM ERECTION

A. The monorail supplier shall receive, unload, and erect the system in accordance with applicable codes and specifications as referenced in the beginning of this specification. Installers shall be employees of the supplier and have five years' experience installing overhead monorails.

B. Holes shall not be drilled or flame cut in any part of the existing structure or other parts of the building structure without permission from the customer's Engineer of Record (EOR).

C. Welding to the building structure must also be approved by the EOR.

3. 2 ELECTRICAL WORK

A. The crane installer shall provide all wiring and electrification in accordance with the National Electric Code from the power supply provided by the customer.

3. 3 FIELD QUALITY CONTROL

A. Acceptance Test
   1. Conduct testing for final acceptance after the erection work has advanced to the point that inspection and testing can proceed without interruption.
   2. Allow inspection of all parts of the crane containing electrical parts or moving mechanical parts by the Engineer.
   3. Test the hoists for capacity, speed and deflections in the presence of the Engineer and owner with 125 percent of the hoist capacity load on the hook. Test weights shall be supplied by crane supplier.
   4. Hoist supplier will transmit to the owner a certificate of load test and compliance with OSHA requirements.

3.44 TRAINING

A. Following the acceptance testing, the supplier will provide up to 4 hours of instruction and field training of operators to meet the requirements of ANSI B30.2 and OSHA 179.1 for Operator Training.

B. The instruction will include but not necessarily be limited to: techniques of safe operation, daily and monthly inspections, minor trouble shooting.

C. The field training will consist of having the operators actually operate the hoists and perform a daily inspection.

D. A written exam will be conducted to insure the operator's understanding and compliance with the required codes of conduct.

END OF SECTION

SECTION 431112 - INTEGRALLY GEARED TURBO CENTRIFUGAL BLOWER

PART 1 – GENERAL

1.01 SCOPE

A. The CONTRACTOR shall furnish, install and place in satisfactory operation three (3) electric motor driven single stage centrifugal blower units and appurtenances as shown on the contract drawings. Aeration blowers, instrumentation, controls, and appurtenances shall be provided as shown on the drawings and as specified herein for a complete and automated aeration system by the MANUFACTURER.

B. All equipment specified in this section shall be designed and furnished by the MANUFACTURER, who shall be responsible for the compatibility of all included equipment.

C. All Electrical and control requirements shall meet the requirements of Division 26 and Division 40

1.02 MANUFACTURER

A. The air blower/motor assemblies, all accessories, and control software shall be supplied by the MANUFACTURER. The MANUFACTURER shall have at least twenty (20) installations of single-stage centrifugal blowers of equal design that have been in operation for at least five (5) years.

B. The Local Control Panel (LCP) and Master Control Panel (MCP) design, programming, fabrication, and testing shall be completed in-house by the MANUFACTURER. This work shall not be outsourced, the purpose being to ensure quality assurance, control, and testing by the MANUFACTURER.

C. The MANUFACTURER's fabrication facility shall be located in the continental United States and shall be UL 508A and ISO 9001 certified to assure conformance to the highest quality standards of the industry. The MANUFACTURER's service group shall also be based in the continental United States and be direct employees of the MANUFACTURER.

D. The MANUFACTURER shall be required to meet the specifications. Equipment which is a "standard product" with the MANUFACTURER, shall be modified, re-designed from the standard mode, if necessary, or furnished with special features, accessories, materials, or finishes as may be necessary to conform to the detailed requirements of these specifications or contract drawings.

E. Lone Star Blower was used as the basis of design for this project. Any differences in cost, design, equipment layout, or planning for adapting the installation to meet these

specifications using another MANUFACTURER's design shall be coordinated and borne by the CONTRACTOR. Any changes to the design shall be reviewed and approved by the ENGINEER.

1.03 SUBMITTALS AND OPERATION & MAINTENANCE MANUALS

A. Submittals during construction, and the Operation and Maintenance Manuals, shall be made in accordance with Section 017823. In addition, provide the information in the following format:

1. Comments and exceptions by specification paragraph. Provide detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt non-specified materials to the arrangement or details shown.
2. General description of blower with all performance data, blower curves, and model information.
3. Mechanical drawings with general arrangement showing blower base dimensions, floor mounting, skid piping, overall weights, and weights of largest components requiring removal for maintenance.
4. Process and instrumentation diagrams.
5. Detailed specification sheets and information for all instruments and ancillary components
6. Main drive motor information shall include:
    a. Detailed specification information.
    b. Dimensional drawings.
    c. Wiring diagrams including ancillary instrument terminal boxes.
7. Main motor starter information shall include:
    a. Detailed specification Information.
    b. Wiring diagrams.
    c. Dimensional and layout drawings.
8. Control panel information shall include:
    a. Detailed specification information.
    b. Wiring diagrams.
    c. Interconnection diagram to all components outside the control system.
    d. Dimensional and layout diagrams.
9. Operating description for the local and master control panels. As a minimum, provide more detailed description than given in this specification, covering all sequences of operation. Typical Operator Interface screens shall be provided with detailed descriptions.

B. In addition to the above, Operation and Maintenance manuals shall include:
1. Unloading, handling, storage, and maintenance requirements.
2. Recommended spare parts list.
3. Recommended lubricants.
4. Instrument settings.

5. Troubleshooting guide.
6. List of components and catalog cuts fully describing all items.
7. Maintenance summary forms.
8. Copy of the test results.

1.04 TOOLS AND SPARE PARTS

A. The MANUFACTURER shall furnish all special tools and appliances necessary to disassemble, service, repair and adjust the equipment and appurtenances. The following spare parts shall be furnished:
   1. Two (2) sets of oil filter cartridges for each unit.
   2. Two (2) sets of inlet air filters for each unit.
   3. Oil sample kit with ten (10) pre-paid postage oil sample containers.
   4. One (1) complete set of blower bearings and seals
   5. One (1) set special tools

B. All spare parts shall be suitably packaged and clearly identified with indelible marking on the containers. Tools and spare parts (except for the air and oil filters) shall be supplied in proper packaging for long-term storage and marked with the MANUFACTURER's name, along with a complete description of contents.

1.05 WARRANTY

A. The Blower Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of one (1) year for the complete blower package and accessories provided. The warranty period shall begin at the date of equipment startup completion or 180 days from shipment (whichever occurs first). The warranty shall cover the entire package provided by the manufacturer.

B. If Phoenix Contact PLC's and accessories provided for control panels: All control panels shall be provided with limited lifetime warranty against defects in materials and workmanship for Phoenix Contact components (warranty provided via Phoenix Contact). The warranty requires a Phoenix Contact power supply and Phoenix Contact surge protector to be used. Additionally, all other control panel components shall be Phoenix Contact brand to maximize the benefit of this warranty. If Phoenix Contact does not have a suitable product for a component, alternate reputable brand products may be submitted for approval.

PART 2 – PRODUCTS

2.01 GENERAL

A. The single stage centrifugal blowers will be used to supply variable volume of air to the _2_ aeration basins (or zones). All items specified in this section shall be supplied by the MANUFACTURER to provide a sole source responsibility for a properly functioning

system, with the objective to minimize power consumption while providing the proper volume of air to the aeration system. All components shall be new. Both workmanship and materials shall conform to all applicable sections of these specifications. It shall be understood that components specified establish minimum requirements only, and do not relieve the MANUFACTURER of responsibility for providing a properly functioning system.

B. The blowers shall be motor driven, single-stage centrifugal, vertical or horizontal split type units complete with integral gearbox and accessories as manufactured by the MANUFACTURER and as described herein. Each blower shall be provided with an axial inlet and radial discharge adjustable in fifteen (15) degree increments.

2.02 DESIGN CONDITIONS

A. Four process aeration blower(s) shall be furnished, each with the following design operating conditions and guarantee points:

1.	Design Flow Rate, SCFM:	1,180-2,800 SCFM
2.	Atmospheric Pressure:	12.6 PSIA @ elevation 4220 ft
3.	Inlet Pressure at Blower Inlet Flange:	12.45 PSIA
4.	Inlet Temperature, High:	120 °F
5.	Inlet Temperature, Low:	0 °F
6.	Relative Humidity, %:	41 %
7.	Discharge Air Pressure:	10 PSIG
8.	Maximum Nameplate HP:	200 HP
9.	Blower Turndown, percent of Capacity:	100 percent to 45 percent
10.	Minimum rise to surge shall be at least 10% of design discharge air pressure	

B. Blowers shall not surge nor exceed the nameplate motor rating over the entire range of operation.

2.03 BLOWER AND INTEGRAL GEARBOX

A. Blower casing shall be made of grey cast iron or ductile iron, ASTM A536-60-40-18, ASTM A48-83, or equal, have a maximum continuous duty design temperature of 400 Deg F, and a design pressure of 50 psig. The blower inlet shall be field connected by the CONTRACTOR, directly to the inlet pipe by a flexible connection supplied by the MANUFACTURER. Air inlet shall be axial through an annular inlet. The blower casing shall be provided with lifting lugs capable of supporting the blower/gearbox.

B. The gear drive housing shall be of close-grained cast iron and sufficiently rigid to maintain the shaft positions under maximum loads. Two inspection ports, with bolt-on covers, shall be provided in the upper portion of the gearbox housing. The ports shall allow access to the gearbox internals for the purpose of inspection. Adjustment of the vibration proximity probes on the high-speed shaft shall be possible from the outside of the gearbox. The requirement to disassemble the gearbox for pinion shaft proximity probe adjustment shall

not be acceptable. A circular, bolt-on plate located on the pinion shaft centerline, opposite the impeller end, shall be removable. This removable plate shall facilitate inspection and replacement of the pinion shaft opposite impeller end journal and thrust bearing without disassembly of the gearbox.

C. Gearbox configuration shall incorporate a single helical gear set. The overhung impeller and pinion shaft shall operate between the first and second critical speeds of the assembly.

D. The blower and gear housing assemblies shall be machined to close tolerances for bearing fit and gear alignment.

E. The gearbox shall be ample size and rated to transmit the maximum torque and horsepower input requirement to the blower under all operating conditions and continuous duty.

F. All exposed machined surfaces shall be coated with grease or rust inhibitor prior to shipment.

2.04 IMPELLERS

A. The impeller shall be of the open radial flow type, with backward leaning blades with a blade angle of greater than 20 degrees and milled from forged aluminum alloy and be anodized. The impeller shall have minimum 16 blades and every second blade shall be cut back (splitter blade) to avoid choke in the impeller inducer section. Radial blades impellers or impellers without splitter blades shall not be allowed.

B. The impeller design shall secure a minimum 10% head rise from the optimum design point to the surge point. All surfaces shall be machined. Cast type aluminum or steel impellers shall not be acceptable. The impeller shall be attached to the pinion shaft by spindle and lock nut. The impeller shall be statically and dynamically balanced. The impeller/shaft shall be designed for operating at peripheral speeds up to 115% of the rated operating speed.

2.05 VARIABLE VANES

A. The inlet guide vane and variable discharge diffuser vane systems shall be furnished to facilitate blower turndown while maximizing efficiency throughout the entire blower operating map. Vanes shall be aerodynamically shaped for maximizing efficiency. Inlet guide and variable discharge vanes shall be constructed of 316 stainless steel. Any other construction material shall not be allowed.

B. Flat steel plates shall not be used for inlet guide vanes or the variable diffuser vanes.

C. An adjustable inlet guide vane assembly shall be provided. Inlet guide vanes shall be made in an aerodynamic, streamlined design in cross-section and located in a radial fashion

around the annular inlet. At least 13 profiled vanes shall be provided and positioned in a velocity increasing air duct to minimize downstream wakes.

D. The variable diffuser assemblies shall be mounted integrally with each blower, multi-leaf and pivoted, and located in cast iron housings. All vanes shall be mounted in permanently lubricated sleeve bearings. Operating linkages for variable diffusers shall be housed within the blowers. Blowers with variable vane assemblies located external to the blower housing and/or have ball and socket linkages or other moving parts requiring periodic lubrication shall not be acceptable.

E. Each vane assembly shall include a direct mounted rotary electric actuator with limit switches for open/close indication to the control system. The actuator shall be powered using 24VDC from the skid mounted remote I/O panel. The limit switch signals shall also utilize 24VDC. Linear actuators and independent floor mounting of the actuator or its operating mechanisms shall not be allowed.

F. The position command and feedback of each set of vanes shall be transmitted to and from the skid mounted remote I/O panel via 4-20mA analog signals. Position of both sets of vanes shall also be indicated by a physical indicator and calibrated dial on the blower casing. The vane position shall be indicated on the local control panel's operator interface.

2.06 SHAFTS, GEARS, SEALS

A. The blower gear shafts shall be machined from heat-treated, forged steel and suitably ground. Any responsive lateral critical speed of the rotating assembly shall be at least fifteen (15) percent from the normal operating speed. Any torsional resonances of the package shall be at least ten (10) percent from the normal operating speed. All shafting shall conform to "Design and Selection of Components for Enclosure Gear Drives" (AGMA 6001-D97).

B. Speed-increasing gear shall be of the helical parallel shaft type. The pinion gear shall be integral with the rotor shaft. The gears shall be made of case hardening alloy steel with the gear teeth precision ground.

C. The gearbox shall be of ample size and rated to transmit the maximum torque and power input requirements to the compressor under all operating conditions and continuous duty. All exposed machined surfaces shall be coated with a corrosion-resistant compound prior to shipment.

D. Air and oil shaft seals are provided to contain the compressed air inside the compressor casings, partly to prevent oil from leaking out of the gearbox, partly to prevent air from entering the gearbox casing and to avoid contamination of the lube oil with compressed air, dirt or moisture.

E. The shaft seals shall be of a non-contact, multipoint labyrinth type, to be operated dry. The high-speed air and oil seals shall be located in a vented chamber. Any leakage shall be minimized by having small clearances between female and male parts. The female parts shall be made of aluminum or bronze to avoid damage to the shaft in the event of a seal rub.

2.07 BEARING

A. All bearings shall be of alloy steel construction. Bronzed backed bearing shall not be allowed.

B. Drive shaft radial bearings shall be cylindrical, journal type. Drive shaft thrust bearings shall be composed of multiple segments designed for thrust in both directions. Antifriction ball bearings shall not be allowed on the drive shaft.

C. Pinion shaft radial bearings shall be steel backed tilting pad bearing for optimum rotor stability and the pads babbitted. The bearings shall be designed to suppress hydrodynamic instabilities and provide sufficient dampening to limit rotor vibrations. Fixed geometry cylindrical sleeve journal bearings and/or antifriction ball bearings shall not be allowed on the pinion shaft.

D. Pinion shaft thrust bearings shall be composed of multiple segments, tapered land type and designed for thrust in both directions. Radial and thrust bearings shall be pressure lubricated with sufficient oil film thickness under all operating conditions.

2.08 COUPLING

A. A forged steel, double-disc, dry type spacer coupling shall be furnished to connect to the blower and motor. Coupling and spacer shall be balanced to AGMA, Class 8, or better, and sized with a minimum service factory of 1.5. Distance between shaft ends (DBSE) shall be a minimum of nine (9) inches. DBSE requirement is so that either shaft hub of the unit may be removed without disturbing adjustment of the other. An OSHA non-sparking guard shall be provided and installed over the coupling and painted Safety Yellow.

2.09 OIL LUBRICATION SYSTEM

A. A lube oil system shall be provided with each blower, integral with the blower skid. A gearbox shaft-driven oil pump shall supply lubrication for the blower gearbox. A separate auxiliary motor driven oil pump shall create oil pressure before the shaft driven pump takes over. The motor driven oil pump shall be mounted integral to the blower skid for easy access, inspection, and replacement. The lube oil system shall include a pressure control valve that returns excess oil to the reservoir so there is a constant pressure supplied to the gearbox.

B. Spider type coupling required for any auxiliary motor mechanical connections.

C. The lube oil system shall be constructed from hydraulic hose or equal. The system shall be thoroughly tested for leaks at the factory prior to shipment. Instrument connection points shall be made either using tee connections or machined instrument mounting blocks.

D. An oil level indicator shall be mounted in an easily seen location on the top of the oil reservoir for quick visual reference of the oil level. Side mounted oil level indication is strictly prohibited.

E. The oil filter shall be of the full flow, replaceable cartridge type, capable of removing particles over 10 microns with a clean oil filter pressure drop not exceeding 15 psi at design temperature and flow.

F. Provide an air-to-oil cooler to maintain constant oil temperature, mounted on each blower skid as well as a bypass line around the cooler. Both the hot and cold line shall combine into a temperature control mixing valve for regulating constant oil temperature to the blower gearbox. The oil cooler shall be powered and controlled by the blower's local control system.

G. Provide the oil lubrication system with a tube-type immersion heater in the reservoir of each blower package. The heater shall be powered and controlled by the blower's local control system.

H. Provide an active oil demister to minimize oil mist escaping to the environment around the blowers. The active oil demister shall utilize a motor-powered fan to create a slight vacuum on the oil reservoir, causing oil mist to collect and drain back into the oil reservoir. The oil demister shall be powered by the blower's local control system and shall operate anytime the blower is running.

2.10 EQUIPMENT BASE AND MOUNTINGS

A. The MANUFACTURER shall furnish a base of adequate size to support the blower, gearbox, motor, lubricating system, and accessories. The base shall be constructed of fabricated A36 steel in an integral welded box configuration with a drip lip, lifting eyelets, and have sufficient rigidity to permit lifting (using a four-point lift) with all equipment mounted.

B. The base shall be fully self-supporting and mounted on spring loaded vibration isolators seismic rated provided by the MANUFACTURER and be suitable to absorb the weight and vibration of the blower assembly without undue stress or distortion. The vibration isolators shall be designed for a transmissibility of less than two (2) percent.

C. The units shall be factory aligned on the base prior to shipment so that only minor adjustments are necessary in the field.

2.11 ELECTRIC MOTORS

A. Each blower shall be provided with a horizontal, constant speed, TEFC, squirrel case induction motor designed in accordance with current NEMA, ANSI and IEEE standards. The motor horsepower shall be equal to, or greater than, maximum normal load that will be imposed at any point in the operating range of the design conditions specified. Each motor shall have a 1.15 service factor with Class "F" insulation. Each motor shall be premium balanced for reduced vibration and supplied with lifting lugs.

B. Motors shall be premium efficiency design. Efficiencies shall be determined in accordance with NEMA Standard MGI-12.53a and IEEE Standard 112, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MGI-12.53b.

C. All motors shall be suitable for operation on 480V power for ambient air temperature up to 120 Deg F. Motors shall be suitable for full voltage, across the line start or reduced voltage starting.

D. The following instrumentation/special features shall be provided per motor.
1. PT100 Bearing RTDs (Drive end and non-drive end)
2. PT100 Winding RTDs (2 per phase)
3. Bearing Vibration Sensors (Drive end and non-drive end)
4. 120V Space Heater

2.12 INLET FILTER SILENCER

A. Each blower shall be provided with an inlet filter/silencer designed for maximum air flow with minimal pressure drop and connected directly to the inlet of the blower via a flexible connector. The coarse pre-filter shall be MERV 8 minimum. The final filter element shall be MERV 11 minimum. The filters shall be sized for a maximum face velocity of 575 FT/minute at peak air flow.

B. Walls of the silencer shall consist of a sandwiched steel outer skin and an acoustical sound deadening material of one inch. The sound insulation shall contain an inert barrier on the inside of the housing. Legs shall be adjustable for vertical positioning and leveling.

C. The integral inlet silencer shall consist of a set of baffles, mounted internally in the filter/silencer between the filter elements and the blower inlet.

D. The filter elements shall be panel or bag-type and removable through steel doors located on each side of the steel housing.

E. The CONTRACTOR shall connect the filter/silencer to the blower inlet via a flexible connector provided by the MANUFACTURER.

2.13 DISCHARGE EXPANSION JOINT

A. Provide each blower with a discharge expansion joint. The expansion joint shall be stainless steel bellows type with the bellows made of AISI 304 stainless and flanges made of AISI 410 and include control rods.

B. The bellows shall be able to alleviate pipe flange deflections caused by thermal expansion and contraction in the piping system, thus reducing the external load imposed from the piping on the compressors. An internal guide pipe shall secure a stable flow and reduce pressure losses.

C. The expansion joints shall be capable of withstanding the pressure under all operating conditions and a temperature range of from 0 to 400°F. EPDM discharge expansion joints are not allowed.

2.14 DISCHARGE CONE/SILENCER

A. Provide a discharge cone/silencer, for field installation by the CONTRACTOR, to increase the blower outlet size to the larger diameter air discharge piping. Maximum sidewall angle increase shall be 7° per side (14 ° total). Minimum 10-gauge carbon steel shall be used with discharge flange and bypass flange size as shown on the Drawings.

B. Instrument connections shall be provided for instruments mounted on the cone/silencer. The inside of the discharge cone/silencer shall be lined with deep layers of sound absorbing material, resistant to high temperatures, and covered by a perforated steel plate (minimum 10-gauge thickness), to form sandwiched layers of the external cone/silencer surface, acoustical material, and internal perforated steel plate.

2.15 BLOW-OFF (BYPASS) VALVE

A. Provide each blower with a steel or cast-iron body blow-off wafer type butterfly valve (field installed and field wired to the skid mounted remote I/O panel by the CONTRACTOR) to allow unloaded startup and shutdown, and shall be suitable for air service up to 250 Deg F.

B. The valve operator shall be a Rotork IQT, 460/60/3, NEMA 4 or Water-Tight, and equipped with open/close limit switches. Controls for the valve shall be provided by the blower control system with limit switch position indication provided on the operator interface.

C. Butterfly valve shall be manufactured by Bray or approved equal manufacturer. Bolting and gaskets for installation shall be provided by the CONTRACTOR.

2.15 MAIN AIR HEADER BLOW-OFF (BYPASS) VALVE

A. Provide one main air header blow-off valve with a steel or cast-iron body blow-off wafer type butterfly valve (field installed and field wired to the Blower Master Control Panel (MCP) by the CONTRACTOR) to allow unloaded startup and shutdown, and shall be suitable for air service up to 250 Deg F.

B. The valve operator shall be a Rotork IQT, 460/60/3, NEMA 4 or Water-Tight, modulating type, and equipped with open/close limit switches. Controls for the valve shall be provided by the blower MCP with limit switch position indication provided on the operator interface.

C. Butterfly valve shall be manufactured by Bray or approved equal manufacturer. Bolting and gaskets for installation shall be provided by the CONTRACTOR.

2.16 DISCHARGE VALVE

A. Provide each blower with a wafer type discharge butterfly valve (field installed and field wired to the skid mounted remote I/O panel by the CONTRACTOR), identical to the blow-off valve, except for size. Suitable for air service up to 250 Deg F.

B. The valve operator shall be a Rotork IQT, 460/60/3, NEMA 4 or Water-Tight, and equipped with open/close limit switches. Controls for the valve shall be provided by the blower control system with limit switch position indication provided on the operator interface.

C. Butterfly valve shall be manufactured by Bray or approved equal manufacturer. Bolting and gaskets for installation shall be provided by the CONTRACTOR.

2.17 CHECK VALVE

A. Provide each blower with a wafer type discharge check valve of the dual plate type with center hinge, spring closure, cast iron body, EPDM seal and aluminum plates, stainless steel springs, and rated for temperatures up to 250 Deg F.

B. The check valve shall be mounted and installed by the CONTRACTOR in a horizontal/vertical (Except vertical downward) run of piping, as shown on the drawings. Check valve shall be manufactured by US Valve or approved equal manufacturer.

2.18 BLOW OFF VALVE SILENCER

A. A carbon steel blow off silencer shall be provided for each blower and main air header blow-off valve. Internal baffles, packed with sound absorbent material, shall direct air flow around three (3) 90 ° turns in an annular flow configuration. The blow off silencer shall be an integral unit, fitted with one (1) flange for direct bolting to the blow off valve, with installation by the CONTRACTOR. Silencer shall be manufacturer's standard design.

2.19 INSTRUMENTATION

A. Instrumentation components shall be provided by the MANUFACTURER. These components shall be factory installed on the blower skid, except as noted. All factory mounted instrumentation shall be pre-wired to a skid mounted remote I/O panel. All field mounted instruments shall be field wired to the skid mounted remote I/O panel or local control panel by the CONTRACTOR, using the Manufacturer's supplied wiring diagrams.

B. Instrumentation for each blower shall include, as a minimum

1. 1st Stage and 2nd stage inlet air filter differential pressure indicating transmitters.
    a. Field mounted and wired by the CONTRACTOR.
    b. Transmitter output shall be 4-20mA.
    c. The transmitter shall have a display for the measured process value.
    d. Shall be Dwyer or Vega, or pre-approved equal.
2. Inlet air temperature sensor.
    a. Pre-installed and wired by factory.
    b. PT100 RTD, Class B.
    c. Shall be Pyromation, or pre-approved equal.
3. Inlet air pressure indicating transmitter.
    a. Pre-installed and wired by factory
    b. Transmitter output shall be 4-20mA.
    c. The transmitter shall have a display for the measured process value.
    d. Shall be Dwyer or VEGA, or pre-approved equal.
4. Inlet mounted blower surge switch.
    a. Pre-installed and wired by factory.
    b. 24VDC, 3-wire, normally closed contact.
    c. Switching frequency of 1000 Hz minimum.
    d. Shall be Turck BI5U, or pre-approved equal.
5. Discharge pressure indicating transmitter.
    a. Field mounted and wired by the CONTRACTOR.
    b. Transmitter output shall be 4-20mA.
    c. The transmitter shall have a display for the measured process value.
    d. Shall be Endress Hauser PTP31B, or pre-approved equal.
6. Discharge temperature sensor.
    a. Field mounted and wired by the CONTRACTOR.
    b. PT100 RTD, Class B.
    c. Shall be Endress+Hauser TH11, or pre-approved equal.
7. Gearbox inlet oil temperature indicating transmitter.
    a. Pre-installed and wired by factory.

b. Transmitter output shall be 4-20mA.
c. The transmitter shall have a display for the measured process value.
d. Shall be Endress Hauser TTR31, or pre-approved equal.

8. Gearbox Inlet oil pressure indicating transmitter.
   a. Pre-installed and wired by factory.
   b. Transmitter output shall be 4-20mA.
   c. The transmitter shall have a display for the measured process value.
   d. Shall be Endress Hauser PTP31B, or pre-approved equal.
9. Oil filter differential pressure transmitter.
   a. Pre-installed and wired by factory.
   b. Transmitter output shall be 4-20mA.
   c. The transmitter shall have a display for the measured process value.
   d. Shall be Ashcroft GC55, or pre-approved equal.
10. Oil reservoir temperature sensor.
   a. Pre-installed and wired by factory.
   b. PT100 RTD, Class B.
   c. Shall be Endress Hauser TH11, or pre-approved equal.
11. Oil level gauge.
   a. Pre-installed by factory.
   b. Vented oil gauge with metal/glass construction.
   c. Shall be marked to provide clear indication of appropriate oil levels.
12. Zero speed switch.
   a. Pre-installed and wired by factory.
   b. 24VDC, 3-wire, normally closed contact.
   c. Switching frequency of 1000 Hz minimum.
   d. Shall be Turck BI5U, or pre-approved equal.
13. Motor amp current transmitter.
   a. Pre-installed in motor terminal box and wired by factory.
   b. Transmitter output shall be 4-20mA.
   c. Shall be Veris H321 or H221, or pre-approved equal.
14. Motor bearing temperature sensors.
   a. Pre-wired by factory.
   b. PT100 RTD, Class B.
   c. Drive end and non-drive end.
15. Motor winding temperature sensors.
   a. Pre-wired by factory.
   b. PT100 RTD, Class B.
   c. Two per phase, one duty / one spare.
16. Motor bearing vibration, drive end and non-drive end.
   a. Pre-installed and wired by factory.
   b. Transmitter output shall be 4-20mA.
17. Gearbox bearing temperature sensors, each radial and thrust bearing.
   a. Pre-wired by factory.
   b. PT100 RTD, Class B.
   c. Two per bearing, one duty / one spare.

18. Gearbox pinion shaft vibration.
    a. Pre-installed and wired by factory.
    b. Transmitter output shall be 4-20mA.
    c. Shall be Shinkawa WK/WKN Series, or pre-approved equal.
19. Header Pressure Transmitter
    a. Provide one (1) discharge main air header pressure transmitter(s) with a 0-15 PSIG range, LCD display, and a loop powered 4-20 mADC output.
    b. Pressure transmitter shall be Endress Hauser or equal.

2.20 SKID-MOUNTED REMOTE I/O PANEL (RIO PANEL)

A. Each blower shall be provided with skid-mounted remote I/O panel for termination of all instrumentation wiring. Additionally, the RIO panel shall provide control and power for skid mounted auxiliary devices and shall include power supplies and transformers for deriving control power. Each assembled RIO panel shall carry a UL label (ULC for Canadian service) certifying the assembled industrial control panel complies with UL 508A.

B. The RIO panel shall be a (Type 4/Type 12) enclosure with two independently operable doors, and each side of the enclosure separated by a physical barrier in between. One side shall only contain 24VDC circuits (low voltage side) and the door be capable of being opened without removing power from the system for the purposes of troubleshooting. The other side shall contain the 480VAC and 120VAC components (high voltage side) and shall include a disconnect to prevent opening of that door while the enclosure is energized.

C. The RIO panel shall be fed from a single 480V/3/60, 30amp source that is field wired by the installing CONTRACTOR to the fused disconnect contained within. A 480V SPD (surge protection device) shall also be included. The RIO panel shall include a transformer for deriving its own 120VAC power and a 24VDC power supply.

D. Three phase motor starters and circuit protectors shall be mounted in the high voltage side of the enclosure for providing power to the skid mounted auxiliary motors and heaters. The contactors shall be controlled from the remote I/O mounted in the low voltage side of the enclosure via interposing relays. Circuit protectors shall also be provided for supplying 480VAC power to the discharge valve actuator and blow-off valve actuator.

E. The RIO panel shall include two grounding systems. One ground busbar for equipment ground and one isolated instrument ground busbar. The installing CONTRACTOR shall connect each grounding busbar to the appropriate site grounding system.

F. An Emergency Stop (E-Stop) mushroom style pushbutton shall be mounted on the low voltage door of the remote I/O panel enclosure. A normally closed contact of the E-Stop shall be in series with an E-Stop contact in the local control panel so that the circuit is broken if either E-Stop button is pressed. A relay shall be used to provide a dry contact

indicating the E-Stop status. This contact shall be either wired directly to the soft starter or put in series with the run signal to the soft starter as per the project drawings.

G. All instrumentation shall be connected via individually fused circuits to a remote I/O system mounted within the RIO panel. The remote I/O system shall have an Ethernet bus for communicating the values of each instrument to the PLC located in the local control panel. The remote I/O system shall be Modicon M340 series Remote I/O. Any additional devices needed to connect instruments to the remote I/O system (such as vibration transmitters) shall also be installed in the RIO panel.

H. Hardwired interconnections to the local control panel shall be limited to an Ethernet cable for connection to the PLC and two conductors for the E-Stop Circuit. Additionally, three conductors (L,N,G) may be used if the local control panel is sourcing its 120VAC power from the RIO panel. Reference the project drawings for the source of the 120VAC to the local control panel.

I. Skid mounted electrical components shall terminate into this enclosure and sufficient terminal blocks shall be provided for field wiring terminations by the CONTRACTOR.

2.21 LOCAL CONTROL PANEL (LCP)

A. Each blower shall be furnished with a PLC-based local control panel (LCP). All controls and instruments shall fail into a safe condition. The controls shall be designed such that the blower cannot operate unless the controls are energized, nor can they operate with any defective controls.

B. The enclosure shall be (Type 4/Type 12) rated and able to be remote mounted or skid-mounted (as shown in the project drawings) . Each assembled LCP shall carry a UL label (ULC for Canadian service) certifying the assembled industrial control panel complies with UL 508A.

C. The control panel shall be powered by a 120VAC source as shown in the project drawings and shall include power supplies within to derive 24VDC control power. A 120VAC SPD (surge protection device) shall be provided for the 120VAC incoming power feed if power is not sourced from the RIO panel.

D. Each blower LCP shall contain controls for blower motor starting, surge and overload detection, shutdown control, alarm and emergency shutdown systems, inlet guide vanes, variable diffuser vanes, discharge valve, blow-off valve, and the oil lubrication system operation.

E. Each LCP shall contain terminal blocks for signals to interface with the main motor starter (Run Command, Run Feedback, Fault Feedback). The starter for the main drive motor shall be installed by the CONTRACTOR as shown in the project drawings.

F. Use destination tagging to identify each end of each wire printed on a wire sleeve marker. Destination tagging identifies the landing point of the other end of the wire.

G. The PLC shall be model M340 and meet requirements of specification section 40 94 43.

H. The HMI shall be a model Magellis and meet requirements of specification section 40 94 33,. At a minimum the HMI shall meet the following requirements:

I. A copy of the PLC and HMI programming software shall be provided to the owner in unlocked, non-password protected format.

J. The operating screens (pages) shall provide not only start-stop and operational mode interfaces, but also alarm status and diagnostics. The following features shall be provided as part of the operator interface screens:

1. Status Bar (all screens) – The top of every screen shall provide a status bar giving status information for primary functions such as running state, alarms, login, local/remote, and operation mode. Additionally, it should be indicated on the status bar if there are any bypass or override values enabled (see Settings Screens).
2. Run/Output Control Screens – The run control screens shall provide the interface for starting/stopping the blower and changing its output. Additionally, under the proper operation modes and login levels, these screens should allow for the starting/stopping of auxiliary devices.
3. Monitoring Screens – The monitoring screens should allow for viewing the blower data and status in different formats at the preference of the operator. The displayed values shall update according to the engineering units selected. At least two visual modes shall be available:
    a. List view with live values and status indicators in a table format. This view shall occupy one screen.
    b. Graphical view showing the live values for each parameter relative to location on the blower equipment.
4. Alarm Screen – The alarm screen shall show any recent alarm conditions from the equipment. Each alarm event shall generate a ‘first out’ alarm indicating the initial cause of the event to aid in troubleshooting in case other alarm conditions occur during the same event.
5. Settings Screens – Settings shall be viewable under all login levels, but shall only allow changes to setpoints and configuration under a technician or administrative level login. Any settings related to the operation of the equipment shall be available via the HMI. This includes, but is not limited to, scaling values, alarm and trip setpoints, timer settings, and other configuration related items. Additionally, each instrument shall have options for an override value or to bypass trips related to the instrument. A bypass or override may only be enabled under a technician or administrative level login and is intended only for temporary use but would provide capability for the blower to be operated in the event of a failed sensor until a replacement can be installed.

K. Panel mounted selector switches, pushbuttons, and indicators shall include:
   1. Emergency stop mushroom button
   2. Remote / Local Selector Switch
   3. Running indicator / pilot light
   4. Alarm indicator / pilot light

L. Surge events shall be avoided using active measures performed by the control system; however, a secondary surge detection system shall sense unbalanced/surge conditions by use of onboard instrumentation. Detection of surge conditions shall trip the blower off-line.

M. Motor overload protection logic shall be provided to control the maximum vane setting on the blower, so that motor current does not exceed a pre-set overload level.

N. A zero-speed sensor shall be mounted on the gear box to detect rotation when it is not expected. This is typically caused by reverse air flow through the compressor caused by a failed isolation valve, check valve, or both. The auxiliary oil pump shall turn on to protect the bearings and the controls shall enter a tripped state.

O. Guide vane actuator position shall be able to be automatically calibrated by use of a button on the local HMI. This function shall only be accessible while the unit is not running and with a tech level, or higher level, login.

P. Data communication shall be provided between the PLC's, located in each LCP and the plant systems via the protocol. Configuring the interface to the plant system shall be the responsibility of the systems integrator; however, the MANUFACTURER shall actively participate by providing proper interface documentation and support as needed.

2.22 MASTER CONTROL PANEL (MCP)

A. Master Control Panel (MCP) shall be provided to control and monitor each individual blower vis the blower’s LCPs in order to achieve desire flow or pressure setpoint and provide control of the main header blow—off valve.

B. The MCP enclosure shall be (Type 4 / Type 4X / Type 12) rated and shall carry a UL label (UL-C for Canadian service) certifying the complete assembled industrial control panel complies with UL 508A.

C. The control panel shall be powered by a 120VAC source as shown in the project drawings and a 120VAC Type2/3 SPD (surge protection device) shall be provided in the panel.

D. IO channels from the PLC shall be pre-wired to terminal blocks and each circuit shall be individually fused. Discrete output channels shall be pre-wired to interposing relays to provide dry contacts for output signals.

E. MCP shall have suitable amount of IO for the field instruments with a minimum of 20% spare channels per channel type.

F. Panel mounted selector switches, pushbuttons, and indicators shall include:
1. Emergency Stop Mushroom Button
2. Multi-Color LED Pilot Light for Status
    a. System Ready to Operate = White
    b. System Running = Green
    c. System Alarm = Amber
    d. System Fault / Tripped = Red

G. The control panel shall be equipped with the following additional accessories and hardware at a minimum:
1. 24VDC power supply for control power
2. Type 3 Surge Protection Device
3. Unmanaged Ethernet Switch with minimum of two (2) spare RJ45 ports
4. 120VAC Receptacle for temporary laptop use

H. The PLC shall be a model AXC F 3152 as manufactured by Phoenix Contact, Allen Bradley Compact Logix model 5069-L306ER, or pre-approved equal.

I. The HMI shall be a model WP 6156-WHPS as manufactured by Phoenix Contact, Allen Bradly PanelView 10", or pre-approved equal.

J. MCP Operator Interface
1. Normal access to the MCP shall be through a touch screen display on the enclosure door. The display shall allow the operator to access alarm details and logged data. The operator shall have the ability to change critical operating parameters such as setpoints from the display and from the SCADA system.
2. Operators shall be alerted to any malfunction/abnormality in the system by a screen alarm on the touch screen display as well as through Ethernet communications to SCADA.
3. Operating parameters shall be field selectable without program modifications through the MCP touch screen.

K. Data Communication with SCADA System
1. Data communication shall be provided between the PLC and the plant systems via the (EtherNet/IP / Modbus / Profinet / Profibus / MQTT / OPC-UA) protocol.
2. Configuring the interface to the plant system shall be the responsibility of the systems integrator; however, the MANUFACTURER shall actively participate by providing proper interface documentation and support as needed.

2.23 MCP OPERATION

A. The MCP shall provide lead/lag sequencing of the blower equipment. The sequence shall be adjustable by the operator and shall call units to run based on a FIFO sequence (First In - First Out).

B. Blowers shall be able to be flagged as out of service by an operator through the MCP interface, which will remove them from service and not allow them to be included in the lead/lag sequence.

C. The MCP shall also provide options for time-based alternations or runtime-based alternations of the equipment.

D. Time based alternations should occur on a set interval and alternate the blowers based on the standard FIFO sequence.

E. A runtime-based rotation will also occur on a set interval but will evaluate the accumulated runtime of each unit and automatically reassign the order to have the units with the least runtime in the highest priority positions.

F. The MCP shall provide both automatic and manual options for controlling the operation of the blowers.

G. Manual Blower Control

1. When the MCP is placed into manual blower control, the operator will select the number of blowers they want to run and set the desired output setpoint.
2. The MCP will then use the lead/lag sequencing functionality to decide which blowers to run and will alternate them as required.
3. The operator setpoint for blower output will be applied to all running blowers.

H. Automatic Blower Control

1. When the MCP is placed into automatic blower control, the MCP shall maintain the total air demand required by the aeration system. The MCP shall establish the number of blowers needed and provide start/stop commands as well as a capacity setpoint to the local control panel of each operating blower.
2. The automatic blower control shall provide options to operate in a Flow Mode, Pressure Mode, or Dual Mode with regard to controlling the blowers.

I. While in flow mode, A header flow setpoint is used for regulating the equipment output and can be configured to be a static setpoint or dynamic value determined by the MCP (for MOV Control). When using a static setpoint, the setpoint can be set locally from the HMI, or remotely from SCADA.

J. Pressure mode should regulate the blower output based on discharge header pressure and can be configured to be a static setpoint or dynamic value determined by the MCP (for MOV Control). When using a static setpoint, the setpoint can be set locally from the HMI, or remotely from SCADA.

K. Dual mode shall utilize both flow and pressure modes as appropriate to maximize system efficiency while also keeping the system stable.

L. Control setpoints shall be adjustable by the operator through the MCP panel touchscreen or the SCADA system. The aeration master control panel (MCP) shall communicate to the Plant SCADA via Modbus TCP. The blower manufacturer shall submit an address map in excel format with the blower submittal with the proposed data to be exchanged.

M. Header Blow-Off valve Control

1. The MCP shall include control logic and I/O for the control of a modulating blow-off valve to relieve pressure from the discharge header when necessary.

2. The header blow-off valve control shall allow for automatic and manual control:

   a. Manual Control: The valve shall go to the % open position commanded by the operator.
   b. Automatic Control: The valve shall be opened by the MCP when the header pressure exceeds a high threshold limit.

3. The header blow-off valve is to be sized by the MANUFACTURER providing the MCP system and should be sized to provide adequate protection and minimize the likelihood of blowers tripping offline due to excess header pressure.

2.24 TESTING

A. Upon completion of assembly, each blower system shall be functionally tested with the local control panel (LCP) connected to all skidded instruments and appurtenances. The oil lubrication system shall be run and tested for leaks. Simulation of the discharge valve and blow-off valve are permitted.

B. The blower system shall be tested in accordance with the ASME Wire-To-Air Performance Test Code for Blower Systems, PTC-13-2018, no exceptions allowed. Tests will be conducted at the blower Manufacturer's US based ISO 9001 certified factory using the actual job motor. The test shall provide verification of the guaranteed points.

C. Blower manufacturer shall demonstrate its test stand, instruments and methods of measurement meet ASME PTC-13 Section 4 and related requirements.

D. All test equipment shall be calibrated and certified by an independent test agency no more than twelve (12) months prior to the test and follow ASME PTC-13 Section 4.

E. Blower system performance boundaries shall match the “as installed” blower system including all process/fluid components and electric power related components as defined in the enclosed Tables 3-5.2-1 and 3-5.2-2 from ASME PTC-13 Section 3.

F. A high-accuracy power analyzer, as defined in ASME PTC-13 Section 4, shall measure the electrical power input to the blower system performance boundaries.

G. Compressor net delivered flow rate and discharge pressure shall be guaranteed with no negative tolerance. Power tolerance for guaranteed points verification shall not exceed ±4%. There shall be no other tolerances or measuring uncertainties used in reporting test results.

H. The OWNER reserves the right to witness testing at any phase or select a third-party witnessing engineer. Expenses for the OWNER or it’s representatives will be the responsibility of the OWNER.

PART 3 – INSTALLATION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed, and the units and equipment are ready for operation.

B. Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.

C. Shipment is not to be made until the MANUFACTURER coordinates shipment to the jobsite with the CONTRACTOR, assuring that the equipment will be properly received and stored.

D. Upon receipt, store equipment in strict accordance with the MANUFACTURER’s instructions and connect and energize motor space heaters (and any other protective devices), as required.

3.2 SURFACE PREPARATION AND SHOP PAINTING

A. All surfaces shall be prepared, shop primed, and painted per MANUFACTURER's standard paint system.

B. Machine surfaces that are not painted shall be protected by coating with grease or corrosion inhibitor.

3.3 INSTALLATION

A. The blowers, motors, all aeration instrumentation, and appurtenances shall be installed by the CONTRACTOR in accordance with the instructions of the MANUFACTURER and as shown on the Drawings. All piping shall be supported to preclude the possibility of exerting undue forces and movements on the blower flanges. Each blower unit shall be mounted on a flat and level concrete pad (± 1/8" surface levelness).

B. The CONTRACTOR shall furnish the required piping, pipe supports, flange gaskets, bolts, nuts, oil, and grease for initial operation in accordance with the MANUFACTURER's recommendations.

3.4 START-UP AND TRAINING

A. The MANUFACTURER shall furnish experienced start-up / service personnel to inspect the final installation and supervise the field start-up tests of the equipment. The services shall be provided for a minimum of two (2) trips each a minimum of four (4), eight-hour (8) days .

B. Start-up shall include tuning of the MCP and main air header blower-off valve to ensure timing, sequencing, and communication with Plant SCADA is functioning correctly to protect the blowers during over pressure occurrences.

C. If there are difficulties in operation of the equipment due to the MANUFACTURER's fabrication, additional service shall be provided at no extra cost to the OWNER.

D. A factory representative, who has complete knowledge of proper operation and maintenance shall be provided for four (4) hours, if necessary, to instruct representatives of the OWNER and Engineer on proper operation and maintenance, including start-up and shut-down procedures, proper lubrication practices, and troubleshooting of all equipment.

END OF SECTION 431112

SECTION 432010 - PUMPS, GENERAL

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide all pumps and pumping appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all pumps and pumping equipment except where otherwise indicated in the Contract Documents.

C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the Work and for coordination of design, assembly, testing, and installation of the Work of each pump Section; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each pump Section. Unless otherwise indicated, the single Manufacturer shall be the Manufacturer of the pump.

D. Single Manufacturer: Where two or more pump systems of the same type or size are required, the pumps shall all be produced by the same Manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 013300 – Contractor Submittals.

B. Shop Drawings: Shop drawings shall contain the following information:

1. Pump name, identification number, and specification Section number.
2. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump. The equipment Manufacturer shall indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions. A family of performance curves at intervals of
3. 100 rpm from minimum speed to maximum speed shall be provided for each centrifugal pump equipped with a variable frequency drive.
   The Contractor shall require the Manufacturer to indicate on the performance curves the
4. limits recommended for stable operation without surge, without cavitation, and without vibration (except vibration within specified allowable limits). The stable operating range
5. shall be as wide as possible based on actual hydraulic and mechanical measurements taken
6. during the factory performance tests of the pumps.
   Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor
7. bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
   Data, in accordance with Division 26 for the electric motor proposed for each pump.
8. Elevation of proposed Local Control Panel showing panel-mounted devices, details of enclosure type, single line diagram of power distribution, and current draw of panel, and list of all terminals required to receive inputs or to transmit outputs from the Local Control Panel.
   Wiring diagram of field connections with identification of terminations between Local Control Panels, junction terminal boxes, and equipment items.
   Complete electrical schematic diagram.

C. Operation and Maintenance Manual: The Manual shall contain the required information for each pump Section.

D. Anchorage: The manufacturer shall provide anchor bolt design calculations in accordance with the latest edition of CBC, stamped and signed by a licensed professional engineer in the State of California.

E. Spare Parts List: A Spare Parts List shall contain the required information for each pump Section.

F. Factory Test Data: Signed, dated, and certified factory test data for each pump system which requires factory testing, submitted before shipment of equipment.

G. Certifications

Manufacturer's certification of proper installation.
Contractor's certification of satisfactory field testing.

1.3 QUALITY ASSURANCE

A. Factory Testing: The following tests shall be conducted on each indicated pump system:

1. Motors: All motors of sizes 100 hp and larger shall be assembled, tested, and certified at the motor factory and the working clearances checked to insure that all parts are properly fitted. The tests shall be in accordance with ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators, and ANSI/IEEE 115 - Test Procedure for Synchronous Machines, including heat run and efficiency tests. All computations shall be recorded and certified and dated copies of the test results shall be furnished.

2. Pump Systems: All centrifugal pump systems 100 hp and larger shall be tested at the pump factory in accordance with the Test Code for Centrifugal Pumps of the Standards of the Hydraulic Institute, Inc. Tests shall be performed using the complete pump system to be furnished, including the motor.

3. For motors smaller than 100 hp, the Manufacturer's certified test motor shall be acceptable. Testing of prototype models will not be acceptable. The following minimum test data shall be submitted:

   a. Hydrostatic test data
   b. A minimum of five hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, recorded on data sheets as defined by the Hydraulic Institute.
   c. Pump curves showing head, flow, bhp, efficiency, and NPSH requirements.
   d. Certification that the pump horsepower demand did not exceed the rated motor hp beyond the 1.0 service rating at any point on the curve.

4. Factory Witnessed Tests: All pumps, variable speed drives, and motors, 150 hp and larger shall be factory-tested as complete assembled systems and may be witnessed by the Owner and Engineer. The use of one of each type project motor and variable frequency drive for testing all pumps shall be acceptable. The Contractor shall give the Engineer a minimum of 4 weeks notification prior to the test. All costs for Owner and Engineer expenses shall be borne by the Contractor and shall be included in the bid price. Such costs shall include travel and subsistence for two people excluding salaries. Test results shall be submitted to the Engineer and no equipment shall be shipped until the test data have been approved by the Engineer.

B. Warranty: Unless otherwise specified, each pump shall be supplied with manufacturer’s standard warranty of one (1) year from substantial completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the individual pump Sections may necessitate modifications to the Manufacturer's standard equipment.

B. Performance Curves: All centrifugal pumps shall have a continuously rising curve. In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor or engine, or encroach on the service factor.

C. No cavitation shall be allowed in pumps operating within the stable operating range for the specified operating conditions. For the purposes of this provision, cavitation shall be recognized and accepted as being present in a pumping unit if cavitation noise can be perceived either by the human ear or by acoustic instruments or devices. The presence or absence of cavitation noise shall be verified by the Owner during both the factory performance tests of the pumps and during operation of the pumps up to the end of the warranty period. To assist in revealing potential cavititation during the factory performance tests, in addition to all other required tests, the Manufacturer shall force the pumps to operate at the specified minimum net positive suction head available for each of the following conditions: minimum flow rate, design flow rate and head, and maximum flow rate.

D. All components of each pump system provided under the pump Sections shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors, variable frequency controls if required, necessary mountings, and appurtenances.

2.2 MATERIALS OF CONSTRUCTION

A. All materials shall be suitable for the intended application; materials not specified shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements:

1. Cast iron pump casings and bowls shall be of austenitic ductile iron, conforming to ASTM A 439 - Specification for Austenitic Ductile Iron Castings, or equal.
2. Bronze pump impellers shall conform to ASTM B 62 - Specification for Composition Bronze or Ounce Metal Castings, or B 584 - Specification for Copper Alloy Sand Castings for General Applications, where dezincification does not exist.
3. Stainless steel pump shafts shall be Type 416 or 316. Miscellaneous stainless steel parts shall be of Type 316.
4. All anchor bolts, nuts, and washers that are not buried or submerged shall be hot-dip galvanized, unless otherwise specified in individual pump Sections. Buried or submerged bolts, nuts, and washers shall be stainless steel in accordance with Section 055000 – Metal Fabrications.

2.3 PUMP COMPONENTS

A. Flanges: Suction and discharge flanges shall conform to ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or B16.5 - Pipe Flanges and Flanged Fittings Dimensions.

B. Lubrication: Vertical pump shafts of clean water pumps shall be product water-lubricated, unless otherwise specified. Deep-well pumps and pumps with dry barrels shall have water- or oil-lubricated bearings and seals and enclosed lineshafts. Pumps for other process fluids shall be lubricated as indicated.

C. Handholes: Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

D. Vortex Suppressors: Vertical pumps with marginal submergence shall be provided with vortex suppressors.

E. Drains: All gland seals, air valves, cooling water drains, and drains from variable frequency drive equipment shall be piped to the nearest floor sink, or drain, with galvanized steel pipe or copper tube, properly supported with brackets.

F. Grease Lubrication: For all vertical propeller, mixed-flow, and turbine pumps, other than deep well pumps, of bowl sizes 10-inches and larger, the Contractor shall provide a stainless steel tube attached to the column for grease lubrication of the bottom bearing.

G. Stuffing Boxes: Where stuffing boxes are indicated for the pump seal, they shall be of the best quality, using the Manufacturer's suggested materials best suited for the specific application. For drainage and liquids containing sediments, the seals shall be fresh-water flushed, using lantern rings.

1. Unless otherwise specified, the packing material shall be interlaced Teflon braiding, containing 50 percent ultrafine graphite impregnation to satisfy the following:
   a. Shaft speeds - up to 2500 rpm
   b. Temperature - up to 500 degrees F
   c. pH range - 0 to 14.

2. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.

H. Mechanical Seals: Mechanical seals shall be fresh water-flushed unless indicated otherwise; in which case product water cleaned by a solids separator as above shall be used. Mechanical seals shall be as manufactured by the following, or equal:

Type	Manufacturer
Wastewater Pumps	Double seals: John Crane Type L Double; Borg-Warner Type L Double; Chesterton
Abrasives, Grit, or Lime Slurry Pumps	Double seals: John Crane Type I (hard faces); Borg-Warner Type L (hard faces); Chesterton
Chemicals or Corrosive Liquid Pumps	Single seals: John Crane Type 8-1, 9; Borg-Warner Type Q, QB; Chesterton
Water Pumps Hot and Cold	Single seals: John Crane, Type I, 21; Borg-Warner Type L; Chesterton

I. Where indicated, a buffer fluid must be circulated a minimum 20 psi above discharge pressure, or as required by the Manufacturer, in order to maintain reliable seal performance.

J. Mechanical seals for all services other than chemicals and corrosives shall be equipped with nonclogging, single coil springs and nonsliding, internal, secondary elastomers. Metal parts shall be Type 316 stainless steel, Alloy 20, or Hastelloy B or C.

2.4 PUMP APPURTENANCES

A. Nameplates: Each pump shall be equipped with a stainless steel nameplate indicating serial numbers, rated head and flow, impeller size, pump speed, and Manufacturer's name and model number. Dimension and flow information shall be in metric units, followed by English units in parentheses.

B. Solenoid Valves: The pump Manufacturer shall provide solenoid valves on the water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical ratings shall be compatible with the motor control voltage.

C. Gauges: all pumps (except sample pumps, sump pumps, and hot water circulating pumps) shall be equipped with pressure gauges installed at pump discharge lines. Pump suction lines shall be provided with compound gauges. Gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.

1. Where subject to shock or vibrations, the gauges shall be wall-mounted or attached to galvanized channel floor stands and connected by means of flexible connectors.
2. Pressure and compound gauges shall be provided in accordance with Section 40 73 13 – Pressure Gauges.

D. Spare Parts: One full set of all recommended spare parts shall be provided with each set of pumps.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: Where required by the individual pump Sections, an authorized service representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to witness the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

1. Installation of the equipment.
2. Inspection, checking, and adjusting the equipment.
3. Startup and field testing for proper operation.
4. Performing field adjustments to ensure that the equipment installation and operation comply with the specified requirements.

B. Instruction of the Owner’s Personnel

Where required by the individual pump Sections, an authorized training representative of the Manufacturer shall visit the site for the number of days indicated in those Sections to instruct the Owner’s personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

The representative shall have at least two years' experience in training. A resume for the representative shall be submitted.

Training shall be scheduled a minimum of three weeks in advance of the first session.

Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.

The training materials shall remain with the trainees.

The Owner may videotape the training for later use with the Owner personnel.

3.2 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the Manufacturer's written recommendations.

B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The Contractor shall provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

A. Materials and equipment shall be coated as required in Section 098000 – Protective Coatings.

3.4 FIELD TESTS

A. Where required by the individual pump Sections, each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.

B. The following field testing shall be conducted:

1. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the Engineer.
2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least four pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.
3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test, unless insufficient liquid volume is available.
4. Electrical and instrumentation tests shall conform to the requirements of the Sections under which that equipment is indicated.

C. Field testing will be witnessed by the Engineer. The Contractor shall furnish 5 days advance notice of field testing.

D. In the event any pumping system fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

E. After each pumping system has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification

shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

F. The Contractor shall bear all costs of field tests, including related services of the Manufacturer's representative, except for power and water which the Owner will bear. If available, the Owner's operating personnel will provide assistance in field testing.

END OF SECTION

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SECTION 432283 - SCREW CLASSIFIER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, equipment, materials and incidentals required to completely install and place into operation the one (1) grit dewatering system(s).

B. The unit(s) shall be furnished and installed with all necessary accessory equipment and auxiliaries, whether specifically mentioned in these specifications or not, and as required for an installation incorporating the highest standards for the type of service specified, including field technician representation during start up of the unit(s), and instruction of the Owner's personnel in the care, operation and maintenance of all equipment.

1.02 RELATED SECTIONS

A. Concrete work is included in Division 3.

B. Metal work is included in Division 5.

C. Field painting is included in Division 9.

D. Instrumentation is included in Division 13.

E. Electrical work, except as specified herein, is included in Division 16.

1.03 SUBMITTALS

A. Provide shop drawings and product data in accordance with Section 013300 for the equipment being furnished, such that the information shall at least include the following:

1. Certified shop drawings showing all details of construction, dimensions and anchor bolt requirements.
2. Descriptive product literature and catalog cuts
3. Complete bill of materials for the equipment.
4. Recommended spare parts list

B. Operation and Maintenance Data

1. Submit operation and maintenance data in accordance with Section 017823.

1.04 REFERENCE STANDARDS

A. American Iron and Steel Institute (AISI).

B. American National Standards Institute (ANSI).

C. American Society for Testing and Materials (ASTM).

D. American Bearing Manufacturers Association (ABMA).

E. American Gear Manufacturers Association (AGMA).

F. National Electrical Manufacturers Association (NEMA).

G. National Fire Protection Association (NFPA).

H. Underwriters Laboratory (UL).

1.05 QUALITY ASSURANCE

A. All equipment covered by these specifications shall be furnished by one manufacturer, and shall be complete including motor and appurtenances. The equipment shall be the product of a single manufacturer regularly engaged in the production of equipment for the specified use. The manufacturer shall have the sole responsibility for the proper functioning of the equipment as furnished.

C. Manufacturers regularly engaged in the manufacture of the grit removal equipment herein and who can demonstrate equipment of this specified design, in actual service for a period of not less than 25 years will be considered as acceptable manufacturers.

1.06 WARRANTY

A. The equipment shall be warranted for a period of one year from the date of start up to be free from defects in workmanship, design or material. If the equipment should fail during the warranty period due to a defective part(s), it shall be replaced in the machine and the unit(s) restored to service at no expense to the Owner.

1.07 DESIGN REQUIREMENTS

A. The grit screw classifier will be an integrated package for separating grit from water and other solids and to discharge a relatively dry grit into a dumpster. The system offered will be fully compliant with the following design criteria and the contents of this specification section.

Inlet pressure range	7-12 psi
Inlet pipe	3 inches
Overflow outlet pipe	4 inches
Vortex finder	1.5 inches
Underflow outlet cone	4 inches
Average underflow to classifier	150 gpm
Number of screw classifiers	one (1)
Maximum classifier capacity	60 GPM

Diameter of screw	6 Inches
Washwater	NA
Length of screw	8 Feet
Speed of screw	12 rpm

B. The manufacturer will provide all necessary information to ensure that the equipment will be coordinated to work in conjunction with the grit chamber and grit removal equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The equipment shall be supplied by a single manufacturer in order to provide standardization for appearance, operation, maintenance, spare parts and manufacturer's service.

B. Subject to compliance with the requirements of the specification the acceptable manufactures and products are:

1. OVIVO.
2. Smith and Loveless.
3. Or Approved Equal

C. Nameplates with the name of the manufacturer, equipment model number and all other pertinent data shall be affixed to each unit at a visible and accessible location.

D. All anchor bolts shall be furnished by the manufacturer and be installed in accordance with the manufacturer's instructions and recommendations.

2.02 SCREW CLASSIFIER

A. General

1. The complete system will be capable of receiving the specified maximum pumped flow rate of waste water containing grit directly from the selected grit chamber. The equipment will be capable of separation so that the waste water containing light organics is returned to the flow and the mineral grit is elevated to a point where relatively dry grit can fall by gravity into a dumpster.
2. The equipment manufacturer will have at least 1,000 completed installations and 25 years of experience supplying vortex grit systems.

B. Screw Classifier

1. The grit and water mixture will enter the screw classifiers 304L Stainless Steel flared inlet hopper that shall provide adequate volume to ensure that the inflow grit and water mixture has sufficient retention time for full separation of the heavy grit from the water

and residual light organic solids. The inlet hopper will contain one overflow weir to drain off the water which will be adjustable to allow precise control of the floatation and removal of light organic solids and to minimize the carry over of fine grit. There shall be no parallel plate separators or other restrictions inside the hopper that can accumulate solids and inhibit performance. The back of the hopper will be fitted with a 2 inch diameter drain connection.

2. The grit will be elevated from the hopper by a 6 inch diameter ASTM A36 Carbon Steel screw with windings formed from 1/4 inch thick plate rotating in a ¼ inch thick 304L Stainless Steel U-shaped trough set at a 20 degree angle. The dewatered grit will drop from the plain end pipe outlet into the dumpster. The screw classifier will be self standing with 304L Stainless Steel support legs.

3. The screw is held between top bearings leaving a 5 gap between the screw flights and the UHMW liner. A protective lining of grit will build up in this space and prevent wear to the equipment. The top end of the screw will be flanged to to facilitate the removal of the screw.

The top of the flights and screw will be supported radially by the reducer internal bearings.

4. The open area of the hopper and trough will be covered with an open mesh cover.

5. The screw classifier design offered will not require any wash water to be added to enhance performance.

2.03 MOTORS

A. General

1. Motors shall be as specified herein and shall also conform to specification Section 260000.

2. The motors shall not be overloaded under any normal operating conditions.

B. Drive motor

1. The drive motor shall be an integral part of the geared motor that is directly shaft mounted to the gear wheel within the gear head. .

2. Each motor shall be a 1.0 HP designed for a 460Volt, 3 phase, 60 Hz suitable for Class 1 Division 1 environments.

2.04 CONTROLS

A. Controls: The following controls shall be supplied with the grit dewatering equipment.

1. Provide a totally enclosed, front access type, 460 volt control panel with a NEMA 4/12, painted steel enclosure.
2. All controls shall be manufactured by a UL508 certified company and shall bear a UL label.
3. The control panel wiring shall be neatly cabled and supported in non-flammable wiring raceways.
4. All control devices and switches required for good quality operation shall be supplied in the control panel.
5. All controls shall meet the requirements of specification division 40

B. Operation

1. The screw classifier will take signal from the grit pump to start and will run throughout the pumping cycle.
2. The screw classifier will run on after the conclusion of the pumping cycle for 0-10 minutes.
3. The screw classifier and automatic lubricator will stop until the next pumping cycle.

2.05 SPARE PARTS AND SPECIAL TOOLS

1. Screw classifier nylon lower bearing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with the approved shop drawings and the manufacturer's installation instructions.

B. Final electrical connections are to be made by the electrical contractor.

3.02 FIELD QUALITY CONTROL

A. A manufacturer provided service person shall be on site for one (1) trip lasting a minimum of one (1) day to perform the following services.

1. Equipment Installation
   a. Inspect the completed installation and note any deficiencies.
   b. Complete and provide the OWNER with a copy of an installation report.
2. Equipment Start-up
   a. Assist in placing the system of equipment into proper operation and making any necessary recommendations and adjustments.
   b. Provide OWNER with copy of start-up report.

3. Equipment Training

   a. Instruct plant personnel in the operation and maintenance of the equipment system specified herein.
   b. Training sessions shall include, but not be limited to, a classroom session and a hands-on session.

END OF SECTION 432283

SECTION 432313 – HORIZONTAL SELF-PRIMING CENTRIFUGAL PUMP

GENERAL

1.1. SCOPE OF WORK

A. The work in this section shall include furnishing and placing into operation 4 horizontally self-priming centrifugal pumps.

PART 1.

1.2. PERFORMANCE CRITERIA

A. The pump manufacturer must be ISO 9001:2008 revision certified, with scope of registration including design control and service after sales activities.

B. The pump manufacturer must be registered to the ISO 14001 Environmental Management System standard and as such is committed to minimizing the impact of its activities on the environment and promoting environmental sustainability by the use of best management practices, technological advances, promoting environmental awareness and continual improvement.

C. Pumps must be designed to handle raw, unscreened, domestic sanitary sewage. Pumps shall have the listed suction and discharge connection. Each pump shall be selected to perform under following operating conditions:

Model	T4A71S or Approved Equal	T6C60SC or Approved Equal
Quantity	2	2
Capacity	200 GPM	500 GPM
Total Dynamic Head	30 FT	25 FT
Maximum Static Suction Lift	2 FT	5 FT
Suction Connection	4 Inch	6 Inch
Discharge Connection	4 Inch	6 Inch

D. Pump Performance Certifications.

1. Solids Handling Capability

a. All internal passages, impeller vanes, and recirculation ports shall pass a 3" spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the engineer, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.

E. Reprime Performance

1. Consideration shall be given to the sanitary sewage service anticipated, in which debris is expected to lodge between the suction check valve and its seat, resulting in the loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate center

line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.

2. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.

3. Pump must reprime 10 vertical ft. at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition. Reprime performance must be confirmed with the following test set-up.

   a. A check valve to be installed down stream from the pump discharge flange. The check valve size shall be equal (or greater than) the pump discharge diameter.

   b. A length of air release pipe shall be installed between pump and the discharge check valve. This line shall be open to atmosphere at all times duplicating the air displacement rate anticipated at a typical pump station fitted with an air release valve.

   c. The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a 2 feet minimum horizontal run, a 90o elbow and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.

   d. Impeller clearances shall be set as recommended in the pump service manual.

   e. Repeatability of performance shall be demonstrated by testing five consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.

   f. Liquid to be used for reprime test shall be water.

   g. Upon request from the engineer, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

F. MANUFACTURER'S WARRANTY

1. The pump manufacturer shall warrant the pump equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. All equipment, apparatus, and parts furnished shall be warranted for sixty (60) months, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

3. Components failing to perform as specified by the engineer, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer.

4. It is not intended that the pump manufacturer assume liability for consequential damages or contingent liabilities arising from failure of any vendor supplied product or part which fails to properly operate, however caused. Consequential damages resulting from defects in design, or delays in delivery are also beyond the manufacturer's scope of liability.

5. This limited warranty shall be valid only when installation is made and use and maintenance is performed in accordance with manufacturer recommendations. The warranty shall become effective on the date of acceptance by the purchaser or the purchaser's authorized agent, or sixty (60) days after installation, or ninety (90) days after shipment from the factory, whichever occurs first.

PRODUCTS

2.1. MANUFACTURER

PART 2.

A. Acceptable manufacturer’s

1. Gorman Rupp
2. Or Equal

B. The specifications and project drawings depict equipment and materials manufactured by The Gorman-Rupp Company. It is not intended, however, to eliminate other products of equal quality and performance. The contractor shall prepare his bid based on the specified equipment for purposes of determining low bid. Award of a contract shall constitute an obligation to furnish the specified equipment and materials.

C. After execution of the contract, the contractor may offer substitutions to the specified equipment for consideration. The equipment proposed for substitution must be superior in construction and performance to that specified in the contract, and the higher quality must be demonstrated by a list of current users of the proposed equipment in similar installations.

D. In event the contractor obtains engineer's approval for equipment substitution, the contractor shall, at his own expense, make all resulting changes to the enclosures, buildings, piping or electrical systems as required to accommodate the proposed equipment. Revised detail drawings illustrating the substituted equipment shall be submitted to the engineer prior to acceptance.

E. It will be assumed that if the cost to the contractor is less for the proposed substitution, then the contract price shall be reduced by an amount equal to the savings.

2.2. PUMP DESIGN

A. Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling raw, unscreened, domestic sanitary sewage. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under PART 1 - GENERAL of this section.

B. The pump manufacturer must be ISO 9001:2008 revision certified, with scope of registration including design control and service after sales activities.

C. Materials and Construction Features

1. Pump casing shall be cast iron Class 30 with integral volute scroll. Casing shall incorporate following features:

a. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.

b. Fill port coverplate, 3 1/2" diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for safety, hand nut threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.

c. Casing drain plug shall be at least 1 1/4" NPT to insure complete and rapid draining.

d. Liquid volume and recirculation port design shall be consistent with performance criteria listed under PART 1 - GENERAL of this section.

2. Coverplate shall be cast iron Class 30. Design must incorporate following maintenance features:

a. Retained by hand nuts for complete access to pump interior. Coverplate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wearplate or check valve without removing suction or discharge piping.

b. A replaceable wearplate secured to the coverplate by weld studs and nuts shall be AISI 1015 HRS.

c. In consideration for safety, a pressure relief valve shall be supplied in the coverplate. Relief valve shall open at 75-200 PSI.

d. Two O-rings of Buna-N material shall seal coverplate to pump casing.

e. Pusher bolt capability to assist in removal of coverplate. Pusher bolt threaded holes shall be sized to accept same retaining capscrews as used in rotating assembly.

f. Easy-grip handle shall be mounted to face of coverplate.

3. Rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, sealplate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:

a. Sealplate and bearing housing shall be cast iron Class 30. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.

i. The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

ii. The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.

iii. Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.

b. Impeller shall be ductile iron, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lockscrew and conical washer.

c. Shaft shall be AISI 4140 alloy steel unless otherwise specified by the engineer, in which case AISI 17-4 pH stainless steel shall be supplied.

d. Bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.

e. Shaft seal shall be cartridge oil lubricated mechanical type. The stationary and rotating seal faces shall be tungsten titanium carbide alloy. Each mating surface shall be lapped to within three light bands flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the sealplate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton; cage and spring to be stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings. Seal shall be warranted in accordance with requirements listed under PART 1 - GENERAL of this section.

f. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.

4. Rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, sealplate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:

   a. Clearances shall be maintained by a four point external shimless coverplate adjustment system, utilizing a four collar and four adjusting screw design allowing for incremental adjustment of clearances by hand as required. Each of the four points shall be lockable to prevent inadvertent clearance increases or decreases due to equipment vibration or accidental operator contact. The four point system also allows for equal clearance gaps at all points between the impeller and wear plate. Requirement of realignment of belts, couplings, etc., shall not be acceptable. Coverplate shall be capable of being removed without disturbing clearance settings. Clearance adjustment systems that utilize less than four points will not be considered.

   b. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above

   c. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

5. Suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the coverplate opening, without disturbing the suction piping. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.

6. Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports. Each spool shall have one 1-1/4" NPT and one 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

D. Serviceability.

1. The pump manufacturer shall demonstrate to the engineer's satisfaction that consideration has been given to reducing maintenance costs.
2. No special tools shall be required for replacement of any components within the pump.

EXECUTION

PART 3.

3.1. EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.2. INSTALLATION

A. Install, level, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacturer at time of delivery.

B. Suction pipe connections are vacuum tight. Fasteners at all pipe connections must be tight. Install pipe with supports and thrust blocks to prevent strain and vibration on pump piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.

C. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to control panel.

D. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up.

E. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

3.3. FIELD QUALITY CONTROL

A. Operational Test

1. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.
2. After construction debris and foreign material has been removed form the wet well, contractor shall supply clear water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems. Be alert to any undue noise, vibration or other operational problems.

END OF SECTION 432313

SECTION 432356 – SLUDGE PROGRESSING CAVITY PUMP

GENERAL

SCOPE OF WORK

PART 1

A. The work to be performed under this section of the specification shall consist of furnishing and installing (6) horizontal, motor driven, progressive cavity pumps model: Xpress 64 7.5 HP Weg WATT Gear CF052 11P132S04E .

1.1

QUALITY ASSURANCE

A. Manufacturer Qualifications

1.2

1. Heavy-duty progressing cavity pump from a manufacture that has been manufacturing progressing cavity pumps for over 45 years. The pumps to be furnished under this Section shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished. The manufacturer will be considered qualified upon examination of credentials and confirmation of satisfactory operation of similar installations in the USA. The following manufactures are acceptable:

a. Wangen model Xpress 64
b. NETZSCH Pumps North America, LLC
c. Seepex
d. Or equal

PART 2

SUBMITTALS

Submittals are required after award of the contract and prior to equipment construction. The contract shall submit, the following:

A. Performance curves; curves to include flowrate, pressure, sliding velocity, required horsepower, toque at operating points and starting torque.

B. Complete specifications for each part to assure compliance with these specifications and should include the following:

1. Materials of construction showing full compliance with specifications
2. Application details and design details which include min/max operating point, suction pressure, discharge pressure, operating speed, sliding velocity, frequency, power required at drive shaft, running torque and starting torque

C. Construction drawings showing complete dimensions, anchor bolts locations, and flange details

D. Weights

E. Warranty

SUBMITTALS REQUIRED AFTER CONSTRUCTION AND PRIOR TO SHIPMENT

A. Six bound copies of operation and maintenance manuals, each copy to include:

1. Sections drawings
2. Parts list with recommended spare parts
2.2 3. Operation instructions
4. Maintenance instructions

TESTING – PUMP AND MOTOR

All complete pumping units (this includes pump, motor, and drive) will be tested on water as a complete unit at the manufacturer's plant before shipment. The testing shall be a complete non-witnessed
PART 3 performance test at the design point(s) and is to include head and capacity, brake horsepower, and efficiency to prove that the pumps to be shipped conform to the requirements to the specification.

The contractor, acting under the instructions of the pump supplier's field representative shall perform a functional field test of all the equipment to prove to the engineer that all components of the system are properly installed and that all equipment will perform in accordance with this specification.

WARRANTY

PART 4

The pump manufacturer shall guarantee the complete pumping assemblies for a period of 12 months after acceptance or 18 months after shipment, whichever occurs first. The warranty as specified here shall cover all defective parts, material, and workmanship.

The responsible manufacturer shall replace all items deemed by the manufacturer to be defective without cost to the owner. Push-Pull is not included.

PART 5

PRODUCTS

General – Unless otherwise stated, the sludge pumps shall be progressing cavity principle suitable for pumping sludge as indicated below:

A. Waste Activated Sludge

B. The progressing pump should meet the following performances parameters:

FLOW: 50-150 GPM

DISCHARGE PRESSURE: 50 PSI

MAXIMUM RPM: 104 RPM @ 50 GPM; 290 RPM @ 150 GPM

MINIMUM HORSEPOWER: 7.5 HP

MANUFACTURERS: WANGEN MODEL: Xpress 64

Suction FLANGE SIZES: 4 -INCH ANSI 150 #

Discharge FLANGE SIZES: 4 -INCH ANSI 150 #

PUMP CONSTRUCTION

PUMP SUCTION AND DISCHARGE CASING

PART 6

6.1

A. The pump casing shall be designed for the type of service specified and shall be of sufficient strength, weight, and metal thickness to ensure long life, accurate alignment, and reliable operation. The suction casing shall be constructed of close-grained cast iron and have two inspection ports. In addition, a drain port should also be at the lowest level of the suction body.

B. The suction and discharge connections shall be ANSI/B16.5 flanges sized for the pump specified. The discharge support feet shall be separate from the discharge flange.

C. The suction body shall be supported with feet on either end independent of the rotor/stator discharge flange

D. Provide 2 square side plates on each side of the pump, 180° apart, large enough to permit easy inspection of the cardan joint and mechanical seal and servicing of pump.

STATOR

6.2

A. The pump's stator shall be formed from a single piece Buna-n rubber sleeve inside a one-piece steel housing with an octagonal shaped discharge end. Split stators or two-piece aluminum shelled stators shall not be acceptable.

B. The stator shall be affixed to the suction casing by the use of four (4) thru-bolts for easy removal and replacement. Stators shall not be affixed to the suction casing by threaded connections or by snap rings. The suction edge of the stator shall be chamfered to allow for unrestricted flow into the pumping elements.

C. The seal shall be integral to the stator sleeve at the suction and discharge to prevent leakage. The use of separate O-rings or flat rings for stator sealing shall not be required.

D. Stator designs that limit nominal pump pressure capability to less than 58 PSI shall not be acceptable.

6.3 E. The stator assembly shall be provided with a PT100 thermistor switch to monitor stator temperature.

ROTOR

6.4

A. The rotor shall be precision machined from tool steel AISI/SAE 304 with a chromium content of 17-19,5% covered with heavy layers of hard chrome plating.

CARDAN JOINT

A. The rotor shall be connected to the motor drive shaft by means of a cardan joint.

DRIVE TRAIN

A. The rotor shall be driven by means of a heavy-duty drive train. The rotor shall be joined to the motor drive shaft by means of a cardan joint with an NBR protective sleeve.

B. The cardan joint shall be joined and driven by hardened pins locked in place by a snap ring.

6.5 C. The cardan joint shall be sealed from the abrasive fluid being pumped, utilizing an NBR protective sleeve held in place with three stainless steel bands. The NBR protective sleeve shall cover the length of the cardan joint and allow for the movement of operation of the cardan joint.

SHAFT SEAL

A. The pumps shall be fitted with a single mechanical seal with Silicon Carbide Seal faces and 304 stainless steel metal parts. The mechanical seal shall be a rubber bellows seal type.

6.6

B. The mechanical seal shall be inside mounted, located inside the pump suction housing with ample open area around the seal and not in a dead-end enclosed housing where solids could accumulate.

DESIGN FEATURES

PART 7

PUMP PERFORMANCE

7.1

A. The suction body of the pump shall be oversized at the entrance of the rotor and stator pumping elements to allow the free flow of high solids materials. The rotor joint head shall be set back from the stator and the leading edge of the stator shall be chamfered so not to restrict the flow into the pumping elements.

B. X-Lift Quick Change System: Pump(s) shall be provided with removable pump discharge flange that in conjunction with the Cardan joint allows for easy removal and exchange of the pump rotor/stator while the pump suction housing stays connected to the suction piping and the discharge piping remains in place. The removable discharge flange shall be 150# ANSI flanged and accept the octagonal discharge end of the stator housing. The removable discharge flange shall mount to a footed support. The discharge flange, stator housing, and footed support shall be connected to the pump body suction PART 8 housing and held in place by four threaded connecting rods. Split stators or two-piece aluminum shelled stators shall not be acceptable.

8.1

DRIVE FEATURES

MOTOR FEATURES

A. The motor shall be an IP55 outdoor rated motor enclosure with class F insulation, 1.15 service factor, Inverter Duty rated. Motor shall be manufactured by Weg WATT.

COATINGS

FACTORY COATING

A. The pump shall be factory coated in RAL 5007 brilliant blue.

PART 9

END OF SECTION 432356

9.1

SECTION 432357 – PROGRESSING CAVITY PUMPS

PART 1 - GENERAL

1.1 SCOPE

A. The work to be performed under this section of the specification shall consist of furnishing and installing horizontal, motor driven, progressive cavity pumps, complete with electric motors and all specified appurtenances. The pumping assemblies are to be installed as shown on the plans. The design conditions of the pump shall be as follows:

1. Pumps shall be specifically designed and selected for continuous duty pumping of:

a. Chemical Dosing of Ferric Chloride and Aluminum Sulfate. The chemical properties shall be as follows:
1) Equipment Tags: P-10331, P-10321, P-38201, P-38101
2) Flow: 1.5 gpm
3) Discharge Pressure: 16 psig

2. The pumps shall be of the compact, close-coupled design. The gear reducer shall be sized for a minimum service factor of 1.5 and designed with a thrust load capability of 150 percent of the actual thrust load.
3. The pumps, along with associated drive appurtenances, shall be mounted on common fabricated steel base plates
4. The pumping units shall be of the self-priming, positive displacement, progressing cavity type specifically designed with a stator consisting of two halves that simplifies the assembly and disassembly when required.

1.2 RELATED WORK

A. Related work specified elsewhere:

1. Section 013300, “Contractor Submittals”
2. Section 098000, “Protective Coatings”
3. Division 26, “Electrical”

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. The pumps, gear reducers, and motors shall be a product of the manufacturers regularly engaged in the manufacturing of equipment having similar service and equal size for a minimum of eight years. The following manufactures are acceptable:
a. Acceptable Manufacturers
1) Wangen
2) NETZSCH Pumps North America, LLC
3) Seepex
4) Or equal

B. MANUFACTURING LISTING

1. The fact that a manufacturer's product is listed above does not imply that its standard product is acceptable. The successful manufacturer will be required to conform to all the written and implied specifications.

1.4 SUBMITTALS

A. Submittals are required after award of the contract and prior to equipment construction. Submittals shall include, but not be limited to the following:
   1. Performance curves; curves to include flowrate, pressure, sliding velocity, required horsepower, toque at operating points and starting torque.
   2. Complete specifications for each part to assure compliance with these specifications and should include the following
      a. Materials of construction showing full compliance with specifications
      b. Application details and design details which include min/max operating point, suction pressure, discharge pressure, operating speed, sliding velocity, frequency, power required at drive shaft, running torque and starting torque
   3. Construction drawings showing complete dimensions, anchor bolts locations, and flange details
   4. Weights
   5. Warranty

B. Submittals required after construction and prior to shipment
   1. Factory data test
   2. Six bound copies of operation and maintenance manuals, each copy to include:
      a. Sections drawings
      b. Parts list with recommended spare parts
      c. Operation instructions
      d. Maintenance instructions

1.5 TESTING – PUMP AND MOTOR

A. All complete pumping units (this includes pump, motor, and drive) will be tested on water as a complete unit at the manufacturer's plant before shipment. The testing shall be a complete non-witnessed performance test at the design point(s) and is to include head and capacity, brake horsepower, and efficiency to prove that the pumps to be shipped conform to the requirements to the specification.

B. The contractor, acting under the instructions of the pump supplier's field representative shall perform a functional field test of all the equipment to prove to the engineer that all components of the system are properly installed, and that all equipment will perform in accordance with this specification.

1.6 WARRANTY

A. The pump manufacturer shall guarantee the complete pumping assemblies for a period of 12 months after acceptance or 18 months after shipment, whichever occurs first. The warranty as specified here shall cover all defective parts, material, and workmanship.

B. The responsible manufacturer shall replace all items deemed by the manufacturer to be defective

without cost to the owner.

1.7 ENVIRONMENTAL CONDITIONS

A. Pumps to be provided under this section will be outside. Environmental conditions are:
   1. Outside, exposed to weather.
   2. Temperature;
      a. Max: 114 degrees Fahrenheit
      b. Min: 30 degrees Fahrenheit

1.8 REFERENCES

A. This section contains references to the following documents. They are part of this section as specified and modified. In case of conflict between the requirements of the section and those of the listed documents, the requirements of this section shall prevail.

1.	AGMA 6010-E-88	Spur, Helical, Herringbone, and Bevel Enclosed Drive
2.	AGMA 6019-E-89	Gear Motors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears
3.	AGMA 6023-A88	Design Manual for Enclosed Epicyclic Gear Drives

PART 2 - PRODUCTS

2.1 PUMP CONSTRUCTION

A. Pump Suction and Discharge Casing
   1. The pump casing shall be designed for the type of service specified and shall be of sufficient strength, weight, and metal thickness to ensure long life, accurate alignment, and reliable operation. The suction casing shall be constructed of close-grained cast iron and have three clean out ports. The casing shall have threaded connections on the suction side and the discharge sides of the pump integral to the casting for vents and gauges. In addition, a drain port should also be at the lowest level of the suction body.
   2. The suction and discharge connections shall be ANSI/B16.1 flanges sized for the pump specified. The discharge support feet shall be separate from the discharge flange.
   3. The suction body shall be supported with feet on either end independent of the rotor/stator discharge flange
   4. Provide 2 square hand-hole side plates on each side of the pump, 180° apart, large enough to permit easy inspection of the rear drive shaft joint and mechanical seal and servicing of pump.
   5. There shall be a top inspection cover integral to the design to allow for inspection of rotor joint and clean out of the suction body. No more than five bolts shall be used to attach the cover.

B. Stator
   1. The pump's stator shall be formed from a single piece Buna-n rubber sleeve inside a one-piece steel housing with an octagonal shaped discharge end.
   2. The stator shall be affixed to the suction casing by the use of four (4) thru-bolts for easy removal and replacement. Stators shall not be affixed to the suction casing by threaded connections or by snap rings. The suction edge of the stator shall be chamfered to allow for unrestricted flow into the pumping elements.

3. The seal shall be integral to the stator sleeve at the suction and discharge to prevent leakage. The use of separate o-rings or flat rings for stator sealing shall not be required.
4. Stator designs that limit nominal pump pressure capability to less than 58 PSI shall not be acceptable.
5. The stator assembly shall be provided with a PT100 thermistor switch to monitor stator temperature.

C. Rotor
1. The rotor shall be precision machined from tool steel SAE 4140 with a chromium content of 11-13.5% hardened to a Rockwell C hardness of C57-60 and then covered with heavy layers of hard chrome plating.

D. Shaft seal
1. The pumps shall be fitted with a single cartridge style mechanical seal with Silicon Carbide Seal faces and 316 stainless steel metal parts. The mechanical seal shall be a rubber bellows seal.
2. The mechanical seal shall be inside mounted, located inside the pump suction housing with ample open area around the seal and not in a dead-end enclosed housing where solids could accumulate.
3. The cartridge style mechanical seal shall be attached and removed along with the drive shaft as one assembly without having to disassemble the gearbox, electrical, or suction/discharge piping. At no time shall the seal faces be exposed during assembly or disassembly.

E. Pump Drive Shaft
1. The drive shaft shall be of the solid drive shaft design in order to avoid clogging and/or trapping of solids, which could either interrupt the movement of the connecting rod or disturb the seal of the rear pin joint. Maximum shaft deflection under normal operating conditions shall not exceed 0.002”. Hollow or telescoping designed drive shafts are not acceptable.
2. The drive shaft shall be solid mounted in two ball or tapered roller bearings. The Anti-Friction Bearing Manufacturer's Association minimum B-10 life expectancy of the bearings shall be in excess of 100,000 hours at the maximum operating conditions of this Specification.

F. Coupling

1. Coupling shall be close-coupled or equal.

G. Priming
1. Where required, a water flush line providing lubrication to the rotor/stator during priming shall be provided.
2. Where required, a double mechanical seal shall be provided to maintain a seal.

2.2 DESIGN FEATURES

A. Pump Performance
1. The suction body of the pump shall be oversized at the entrance of the rotor and stator pumping elements to allow the free flow of high solids materials. The rotor joint head shall be set back from the stator and the leading edge of the stator shall be chamfered so not to

restrict the flow into the pumping elements.

2.3 DRIVE FEATURES

A. Motor features
1. The motor shall be inverter duty rated, Premium Efficient with Class H insulation, 1.15 service factor.

B. Gear Reducer Features
1. The gear reducer shall be parallel in-line helical reducer with a 1.4 service factor. The gear case is to be single piece SAE 30 gray cast iron with internal reinforcements for strength rigidity. This design eliminates oil leakage, oil contamination, and gear set misalignment problems common to drives with bolt-on output cover or flanges.

PART 3 - EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Secure start-up service for pump as specified below:

SCHEDULE OF FIELD SERVICE REPRESENTATIVE ON SITE TIME		
Service	On Site Time (Days)	Trips to Site
Equipment delivery verification and installation instruction	1	1
Installation verification, start-up and instruction of the Owner's personnel	1	1
TOTAL	2	2

B. A "Day on Site" is defined as a conventional 8-hour workday excluding travel time. A "Trip to Site" is defined as complete round trip travel from the Manufacturer's factory. All expenses including salary, local/long distance travel, lodging, meals and any other per diem or miscellaneous expenses of the authorized service representative shall be the responsibility of the Contractor.

C. A factory representative of the pumping equipment shall be present to supervise start-up and ensure proper operation of all components. The Contractor shall obtain and pay for the factory representative start-up service.

3.2 INSTALLATION

A. The pumps shall be installed as specified and in accordance with manufacturer's written recommendations.

3.3 TESTING

A. After completion of installation, the pumps shall be completely tested to demonstrate compliance with operating requirements as specified.

END OF SECTION

SECTION 432513 – SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.1 SCOPE OF SUPPLY

A. This section includes solids-handling, electric submersible pumps to be supplied with integral electric motor, discharge elbow, guide bar brackets and installation accessories. Pumps furnished under this specification are units with discharge connections of four inches in diameter, or larger, and motor ratings of three horsepower, or larger.

1.2 RELATED SECTIONS

A. Common Motor Requirements for Equipment, Section 220513

B. Pump, General, Section 432010.

1.3 CONDITIONS OF OPERATION

A. Each pump shall be capable of pumping at the hydraulic conditions shown in the pump schedule or on the drawings.

1.4 SUBMITTALS

A. Complete assembly, foundation support, and installation drawings, together with detailed specifications and data covering pumps, motors, material used, parts, devices and other accessories forming a part of the equipment furnished shall be submitted for approval in accordance with the procedure set forth in the General Conditions.

B. Data and specifications for the equipment shall include, but shall not be limited to the following:

Setting plans. Setting plans shall include:

a. Anchor bolt layout
b. Anchor bolt dimensions.
c. Outline dimensions and weights of pumps, bases, motors, and control enclosures.

C. Pumps. Data and drawings shall include:

1. Manufacturer, type and model number.
2. Assembly drawing, nomenclature and material list, O & M manual, and parts list.
3. Type, manufacturer, model numbers, location and spacing of bearings.
4. Impeller type, diameter, thru-let dimensions, sphere size, number of vanes and identification number.
5. Complete motor performance data including: rating, voltage/phase/frequency; design type; service factor; insulation class; motor pole number; actual rotation speed when combined with the specified pumps; current, power factor and active input power (KW) as a continuous function of shaft power from no load to at least 115 percent load; start (max. inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous

function through the motor start cycle from no rotation to synchronous speed.

6. Complete performance test curve(s) showing full range (shutoff to run-out) head vs. capacity, NPSHR, hydraulic efficiency, motor active (KW) input power, motor total (KVA) input power (based on measured current and voltage), and shaft power (BHP). VFD pump curves shall be provided where pumps are indicated to operate on VFDs.
7. Location and description of Service Centers and spare parts stock.
8. Warranty for the proposed equipment.

D. The manufacturer shall indicate, by arrows to points on the Q/H curves, limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible, and shall be based on actual hydraulic and mechanical characteristics of the units and shall meet the hydraulic performance requirements of the proposed system.

E. Anchorage: The manufacturer shall provide anchor bolt design calculations stamped and signed by a licensed professional engineer in the State of Utah.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pump Schedule. Submersible pumps of varying sizes and orientations shall be installed in the Headworks and the MBBR Pump Station. Four (4) pumps shall be installed in the Headworks, and four (4) in the MBBR Pump Station as follows:

Tag	Location	Orientation	Model	Power (HP)	Voltage (V)	Remarks
P-10130	Pump Station 1	Dry Pit, Horizontal	FLYGT NZ 3315 LT3-814	90	480	
P-10140	Pump Station 1	Dry Pit, Horizontal	FLYGT NZ 3315 LT3-814	90	480	
P-10150	Pump Station 1	Dry Pit, Horizontal	Relocated from Existing Headworks	90	480	Contractor to provide Horizontal Z-Stand Mounting Base
P-10160	Pump Station 1	Dry Pit, Horizontal	Relocated from Existing Headworks	90	480	Contractor to provide Horizontal Z-Stand Mounting Base
P-31330	MBBR Pump Station	Wet Pit, Vertical	FLYGT NZ 3315 LT3~814	90	480	
P-31340	MBBR Pump Station	Wet Pit, Vertical	FLYGT NZ 3315 LT3~814	90	480	
P-31350	MBBR Pump Station	Wet Pit, Vertical	FLYGT NZ 3315 LT3~814	90	480	
P-31320	MBBR Pump Station	Wet Pit, Vertical	FLYGT NP 3301 LT~816	60	480	

B. The following are acceptable:

1. FLYGT (Basis of Design)
2. or Approved Equal

C. A manufacturer's being named in this specification notwithstanding, all equipment approved for this project shall meet or exceed all performance, service, and warranty requirements of this specification. Standard product must be modified, if required, for compliance. Manufacturer shall have installations of like or similar application with a

minimum of 5 years' service for this pump size.

2.2 MATERIALS – SUBMERSIBLE PUMPS

A. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities.

B. All exposed nuts or bolts shall be of stainless steel construction.

C. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

D. Sealing design shall incorporate **metal-to-metal contact** between machined surfaces.

E. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings.

F. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

G. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

H. Where indicated in the pump schedule, each unit shall be provided with an integral motor cooling system. A motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation.

1. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid trough the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer.
2. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F. (40°C.).
3. Operational restrictions at temperatures below 104°F are not acceptable.
4. Fans, blowers or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

I. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection.

J. There shall be no need for personnel to enter the wet-well to access the pumps.

K. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable.

L. No portion of the pump shall bear directly on the sump floor.

M. The pump(s) shall be suitable for use in Class I, Division 1 “C” & “D” hazardous locations.

N. The pump shall be capable of running in a continuous non submerged condition in a liquid with a temperature up to 104°F (40 °C). The motor shall be capable of no less than 30 evenly spaced starts per hour and be able to operate throughout the entire pump performance curve from shut-off through run-out even when the motor is not submerged.

O. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. It shall be permanently submersible according standard IEC 60034 and protection class IP 68.

P. The stator windings shall be insulated with moisture resistant Class H insulation rated for 356°F.

2.4 TEMPERATURE PROTECTION

A. Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor.

B. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.

C. The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump control panel.

D. Pumps shall be rated by a national testing Laboratory for use in Class 1 Div 1 Group C & D locations and rated Explosion-Proof .

2.5 SEAL LEAKAGE MONITORING

A. Furnish a monitoring system to signal seal leakage.

B. Provide a sensor in the motor’s stator cavity which allows a control panel mounted relay to indicate leakage into the motor.

PART 3 - FABRICATION

3.1 GENERAL

A. The pumps shall be suitable for pumping raw, municipal sewage (2 ¾” min. solids) and shall be designed and fully guaranteed for this use.

B. The fluid temperature range shall be from 40 degrees to 104 degrees F.

3.2 IMPELLER AND WEAR RINGS

A. The impeller shall be of Hard-IronTM (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design.

B. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction.

C. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater.

D. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater.

E. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw.

F. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

G. The impeller shall not use coatings to provide a surface hardening

3.3 SHAFT

A. The pump and motor shaft shall be a single piece unit.

B. The pump shaft is an extension of the motor shaft. Shafts using mechanical couplings shall not be acceptable.

C. The shaft shall be ASTM A479 S43100-T. Shaft sleeves will not be acceptable.

3.4 SHAFT SEAL

A. Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring.

B. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide ring.

C. The upper secondary seal, located between the seal chamber and the seal inspection chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system.

D. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable.

E. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable.

F. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.

G. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion.

H. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.

I. The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

J. A separate seal leakage chamber shall be provided so that any leakage that may occur past the upper, secondary mechanical seal will be captured prior to entry into the motor stator housing. Such seal leakage shall not contaminate the motor lower bearing.

K. The leakage chamber shall be equipped with a float type switch that will signal if the chamber should reach 50% capacity.

3.5 BEARINGS

A. The integral pump/motor shaft shall rotate on two bearings.

B. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease.

C. The upper motor bearing shall be a single ball type bearing to handle radial loads. The lower bearing shall be a two-row angular contact ball bearing to handle the thrust and radial forces.

D. The minimum L_{10} bearing life shall be 50,000 hours at any usable portion of the pump curve.

3.6 VOLUTE/SUCTION COVER

A. The pump volute shall be a single piece grey cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller.

B. Minimum inlet and discharge size shall be as specified.

C. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed.

D. The insert ring shall be cast of Hard-IronTM (ASTM A-532 (Alloy III A) 25% chrome

cast iron) and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

E. The wear plate shall not use coatings to provide a surface hardening

3.7 ACCESSORIES

A. Pumps shall be supplied with the following:

1. Cast iron, epoxy coated, flanged discharge elbows and stainless steel anchors;
2. Stainless steel guide rails as shown in the design drawings.
3. Stainless steel guide rail upper brackets.
4. Stainless steel lifting chain with sufficient length to reach crane system – refer to design drawings.
5. Stainless steel power cable hangers.

3.8 ANCHOR BOLTS

A. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Anchor bolts, hex nuts, and washers shall be # T-316 stainless steel unless noted otherwise. Anchor bolts shall be threaded rods with washers and nuts embedded. Expansion-type anchors will not be acceptable. Anchor bolt design shall be completed by a professional engineer licensed in the State of Utah and shall be included in the submittal.

B. Anchor bolts shall be set by the CONTRACTOR. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout

PART 4 - EXECUTION

4.1 INSTALLATION

A. Installation in strict accordance with the MANUFACTURER'S instructions and recommendations in the locations shown on the Drawings. Installation shall include any alignment, anchoring or grouting required for proper installation. Additionally, installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the MANUFACTURER'S recommendations. Anchor bolts shall be set in accordance with the MANUFACTURER'S recommendations.

B. Upon completion of the installation, the CONTRACTOR shall submit a certificate from the MANUFACTURER stating that the installation of the equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and are of each unit.

4.2 EQUIPMENT TESTING

A. General. Equipment shall be shop tested and field tested as specified hereinafter. All costs for the tests shall be borne by the Contractor. The Contractor shall submit the complete shop test procedures to the Engineer for approval at least 30 days prior to the shop test. In

the event any equipment fails to meet the performance values set forth in this specification, the equipment shall be modified and re-tested or replaced with equipment that performs in accordance with this specification.

B. Shop Tests

1. Pumps and Motors. Each pump and motor shall be performance tested as specified hereinafter; all pumps shall be tested with motor cables to be supplied with the pumps. Three copies of certified test reports, including actual test records, shall be submitted and approved by the Engineer prior to shipment of the equipment.
2. The Contractor shall submit the complete pump test procedure, a diagram of the test setup showing location of instruments, a sample of the test stand log sheet, and calibration data of all instruments and measuring devices to be used by the manufacturer to the Engineer, for approval, prior to the pump tests.
3. Each pump shall be tested for performance at the factory to determine the head vs. capacity, motor total electrical power draw (KVA), and motor active electrical power draw (KW) for the full speed at which the pumps are specified and shown on a performance test curve, certified by a registered professional engineer, as continuous functions throughout the pump's performance range. Tests of models, prototypes or similar units will not be acceptable.
4. All tests shall be run in accordance with the test code for centrifugal pumps of the Standards of Hydraulic Institute, latest edition. The motor and cable on each pump shall be tested for moisture content or insulation defects. After the test, the pump cable end shall be fitted with a shrink-fit rubber boot to protect it from moisture or water.

C. Field Tests

1. Equipment shall be field tested as specified hereinafter. Field testing shall be composed of preliminary tests and acceptance tests as described in the Commissioning Section of the specifications (Division 1).
2. The Contractor shall provide the services of authorized equipment supplier's representatives to conduct all field tests for a minimum of two (2) days and two (2) trips.

END OF SECTION

SECTION 434144 – DOUBLE WALL HIGH DENSITY CROSS-LINKED POLYETHYLENE STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install double wall, high density cross-linked polyethylene tank(s) and accessories, complete and in place, in accordance with the Contract Documents. Contractor and supplier shall provide tank and all its accessories including nozzles, flange connections, access ports, man ways, anchors, tie downs, restraints, and all other appurtenances for a complete storage tank system as indicated in the design drawings and as recommended by the manufacturer.

B. Contractor and tank supplier are responsible to furnish all restraint, and seismic restraints required for each tank in accordance with all local building and mechanical code requirements. Tank supplier shall furnish calculations and design criteria for each tank supplied. Calculations shall include anchor bolt layout and design, and all calculations shall be stamped and signed by a licensed engineer in the State of Utah

1.2 REFERENCE, CODES AND STANDARDS

A. American Society of Testing Materials (ASTM):

1.	D638	Tensile Properties of Plastics
2.	D883	Standard Definitions of Terms Relating to Plastics
3.	D1505	Density of Plastics by the Density Gradient Technique
4.	D1525	Test Method for Softening Temperature of Plastics
5.	D1693	ESCR Specification Thickness 0.125” F50-10% Igepal
6.	F412	Standard Terminology Relation got Plastic Piping Systems

B. ANSI Standards: B-16.5. Pipe Flanges and Flanged Fittings

C. ARM: Low Temperature Impact Resistance (Falling Dart Test Procedure)

D. ASTM D-1998: Standard Specification for Polyethylene Upright Storage Tanks

E. The latest edition of all other applicable codes that are enforced by local authorities including: the latest version of IBC, 2021 IMC, are applicable unless earlier editions are specifically listed in the general design criteria of the design drawings.

1.3 SUBMITTALS

A. Shop Drawings: Shop Drawings: Shop drawings shall be approved by the engineer or contractor prior to the manufacturing of the double wall tank(s). Submit the following as a single complete initial submittal. Sufficient data shall be included to show that the product conforms to Specification requirements. Provide the following additional information:

1. Double wall tank and fitting material

    a. Resin manufacturing data sheet

    b. Fitting material

    c. Gasket style and material

    d. Bolt material

2. Dimensioned Tank Drawings

    a. Location and orientation of molded in fitting, openings, fittings, accessories, restraints, and supports.

    b. Details of openings, fittings, manways, flexible connection, vents, ladders, supports, and other items attached to or directly related to the tank.

3. Factory Test Report including:

    a. Material, specific gravity rating at 600 psi and 100 degrees F.

    b. Wall thickness verification.

    c. Fitting placement verification

    d. Impact test, gel test, and hydrostatic test results.

4. Calculations shall be stamped and signed by a registered, third-party engineer in the State of installation.

    a. Hoop stress shall be calculated using 600 psi @ 100 degrees F.

    b. Include seismic and wind criteria for tank restrain system.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Contractor shall be responsible to arrange delivery, unloading, handling, storage, and installation of the tank. Contractor shall follow all guidelines and recommendations from the manufacturer.

1.5 QUALITY ASSURANCE

A. The Contractor shall provide a vertical, double wall, high density cross-linked polyethylene tank with 110% secondary containment.

B. Tanks shall be of the size, capacity, and nominal dimensions indicated in the design drawings. Even minor variations from the design drawings must be approved by the Engineer.

C. Tanks shall be of the make and model indicated in mechanical schedule as supplied by Poly Processing Company or equal. Any supplier must have at least 10-years' experience in manufacturing and supplying chemical storage tanks.

D. Tanks shall be manufactured from virgin materials.

1. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.

2. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

1.6 WARRANTY

A. Manufacturer shall include a 5-year full replacement warranty.

PART 2 – PRODUCTS

a) GENERAL:

i) Tanks shall be rotationally-molded, high density cross-linked polyethylene, double wall, flat-bottom tanks. Tanks shall be adequately vented as prescribed in Poly Processing Company's Technical Bulletin, Venting-Design for ACFM (air cubic feet per minute). Where indicated, tanks shall be provided with ancillary mechanical fittings and accessories. Tanks shall be marked to identify the manufacturer; date of manufacture and serial numbers must be permanently embossed into the tank.

ii) Refer to the design drawings for specific details on each storage tank application including capacity, dimensions, fittings, accessories, and other application-specific requirements. Note that the chemical being stored in each individual tank may vary – refer to the design drawings and the following sections for details regarding the media to be stored in each application.

b) POLYETHYLENE STORAGE TANKS

i) High Density Cross-linked Polyethylene resin used in the tank manufacture shall be Poly CL™ or equal and shall contain ultraviolet stabilizer as recommended by resin manufacturer. Where black tanks are indicated, the resin shall have a carbon black compounded into it. The tank material shall be rotationally molded and be a resin that is commercially available at the time of tank manufacture.

ii) Wall thickness for a given hoop stress is to be calculated in accordance with ASTM D 1998. In NO case shall the tank thickness be less than design requirements per ASTM D 1998.

1. The wall thickness of any cylindrical portion at any fluid level shall be determined

by the following equation:

$T = P \times OD/2SD$ or $0.433 \times SG \times H \times OD/2SD$

Where: T = wall thickness, in
P = pressure, psi
SG = specific gravity, gm/cc
H = fluid head, ft
OD = outside diameter, ft
SD = hydrostatic design stress

iii) The minimum wall thickness shall be sufficient to support its own weight in an upright position without external support but shall not be less than 0.187" thick.

iv) On closed top tanks the top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall be equal to the thickness of the top of the straight sidewall. In most cases, flat areas shall be provided for attachment of large fittings on the dome of the tank. The bottom head shall be integrally molded with the cylindrical wall. Knuckle radius shall be a minimum of 1-inch for tank diameters ≤ 6-feet and 1.5-inches for tank diameters larger than 6- feet.

v) Tanks with 3000 gal capacity or larger shall have at least 3 lifting lugs. Lugs shall be designed for lifting the tank when empty.

vi) Unless otherwise indicated by Contract drawings, for indoor pneumatic fill, manways shall be 24-in diameter or greater and shall be provided with a bolted manway cover. equipped with an emergency pressure relief device with pressure relief at 6" water column to prevent over-pressurization. Gaskets and applicable accessories shall be closed cell, cross-linked polyethylene foam, Viton, or EPDM materials, compatible with the chemical to be stored.

vii) Unless otherwise indicated, tanks less than 2000 gallons in non-pneumatic applications shall have a manway cover 17-in or smaller of Polyethylene material with a coarse thread. Gaskets shall be closed cell, cross-linked polyethylene foam, Viton or EPDM materials.

viii) Tanks must be vented to allow for performance at atmospheric pressure, in accordance with the following matrix and per manufacturer's recommendations:

Venting Requirements For Polyethylene Tanks

Mechanical Pump Fill	**Pneumatic Fill**								
IF ≤ 1000 gallons	**IF** - Vent length ≤ 3 feet			**IF** - Vent length > 3' and ≤ 30'			**IF** - Scrubber Application		
Vent size should equal size of largest fill or discharge fitting	**AND - Vent** screen mesh size ≥ 1/4" or no screen used			**AND** - 3 or less 90° elbows with no other restrictions or reduction in pipe size			**Vent pipe size throughout scrubber system *CANNOT* be reduced!** Centerline of dispersion pipe not to be submersed > 6 inches		
IF > 1000 gallons	**Emergency Pressure Relief Cover Required**			**Emergency Pressure Relief Cover Required**			Perforated dispersion pipe must be same diameter or larger, as vent. Sum of perforations ≥ cross sectional area of pipe		
Vent size should exceed the largest fill or discharge fitting by 1 inch	Tanker Discharge	Inlet/Fitting Size	Minimum Vent Size	Tanker Discharge	Inlet/Fitting Size	Minimum Vent Size	Tanker Discharge	Inlet/Fitting Size	Minimum Vent Size
	2"	2"	4"	2"	2"	6"	2"	2"	6"
	3"	2"	6"	3"	2"	6"	3"	2"	8"
	3"	3"	6"	3"	3"	8"	3"	3"	10"

(2) 2 inch vents **DO NOT EQUAL** 4 inch venting capacity rev. Nov 2006
For detailed venting guidelines, please visit our Technical Resources at www.polyprocessing.com

ix) Tank colors shall be natural (un-pigmented) and shall be approved by Owner and Engineer prior to manufacture.

x) Acceptable Manufactures:

(1) Poly Processing

(2) Or Equal

c) TANK ACCESSORIES

i) Ladder

(1) Painted Carbon Steel, Fiberglass, or Stainless Steel access ladders shall be provided with the polyethylene chemical storage tanks at locations as shown. Safety cages shall be added to ladders as required, per OSHA.

(2) Ladders must be secured to the tank and secured to the concrete to allow for tank expansion/ contraction due to temperature and loading changes. Use proper chemical resistant materials when anchoring to tank dome or sidewall. See Tank Manufacturer's Installation Manual.

(3) All ladders shall be designed to meet applicable OSHA standards. Reference: OSHA 2206; 1910.27; fixed ladders.

ii) Restraint System: Metal components to be stainless steel tension ring with stainless steel cables and clamps. Tank restraint system shall be supplied and the design of same certified by a Structural Engineer registered in the State of tank installation. Design shall conform to the most recent edition of the IBC code for seismic and wind load. Anchor bolts as required by the calculations shall be supplied by the tank manufacturer and shall be fabricated from stainless steel.

iii) Fittings

(1) Tank fittings shall be coordinated with drawings package. Threaded fittings shall use American Standard Pipe Threads. If tanks are insulated, fittings shall be installed at the factory prior to application of the insulation.

(2) Bolted flange fittings shall be constructed of one 150 lb. flange with ANSI bolt pattern, one flange gasket and stud bolts with gaskets. Stud bolts to have chemical resistant polyethylene injection molded heads and gaskets to provide a sealing surface between the bolt head and the interior tank wall. Stud bolt heads are to be color coded for visual ease of identifying the bolt material by onsite operators. Green- 316 Stainless Steel, Black- Titanium, Red- Alloy C-276, Blue- Monel. All materials shall be compatible with chemical service and as indicated in the fitting schedule above. For NSF/ANSI 61 certification, EPDM or Viton GF gaskets shall be supplied.

(3) For sodium hypochlorite and sulfuric acid storage, Bolted One-Piece Sure Seal (B.O.S.S.), double flange fittings constructed of virgin polyethylene shall be supplied. Bolts will be welded to a common backing ring and encapsulated with polyethylene preventing fluid contact with the metal material. Flange will have one full face gasket to provide a sealing

surface against inside tank wall. All materials shall be compatible with chemical service and as indicated in the fitting schedule above. For NSF/ANSI 61 certification, EPDM or Viton GF gaskets shall be supplied.

(4) Down Pipes and Fill Pipes: Down pipes and fill pipes shall be supported at 6-ft max intervals. Down pipes and fill pipes shall be PVC or material compatible with the chemical stored.

(5) U-Vents: Each tank must be vented for the material and flow and withdrawal rates expected. Vents should comply with OSHA 1910.106(F)(iii)(2)(IV)(9). U-vents shall be sized by the tank manufacturer and be furnished complete with insect screen if required (Insect screen lessens the vent capacity by 1/3) in accordance with the venting schedule listed above.

(6) On dual wall tank(s) greater than 1000 gallons, bottom fitting(s) must be designed to maintain 110% secondary containment integrity by using a Bellows transition Style II Fitting. Bottom containment fitting must include PTFE expansion joint designed to accommodate movement of primary tank in design accordance with ASTM-D 1998 tolerances. All secondary containment fittings and parts shall be resistant to chemical fume corrosion. Fitting shall include the option to connect a secondary containment pipe over primary pipe.

(7) All fittings on the 1/3 lower sidewall of tanks with capacities $\geq$ 1000 gallons shall have 100% virgin PTFE Flexijoint® expansion joint. Expansion joint to have 3 convolutions, stainless steel limit cables, FRP composite flanges and meet the following minimum performance specifications. Galvanized parts will not be accepted. Expansion joints to meet the following minimum performance requirements:

(a) Axial Compression $\geq$ 0.67”
(b) Axial Extension $\geq$ 0.67”
(c) Lateral Deflection $\geq$ 0.51”
(d) Angular Deflection $\geq$ 14º
(e) Torsional Rotation $\geq$ 4º

iv) Float Level Indication: The level indicator shall be assembled to the tank and shall consist of PVC float, indicator, polypropylene rope, perforated interior pipe, PVC roller guides, clear UV resistant PVC sight tube and necessary pipe supports. The level indicator shall act inversely to the tank contents and shall not allow entrance of tank contents into the sight tube at any time. Indicator shall be neon orange color for visual ease for onsite operators.

v) Leak Detection:

(1) Tank manufacture shall provide leak detection. Leak detecation shall have the following:
(a) High intensity red alarm
(b) Pulse to Relay Output
(c) NEMA 4X enclosure.
(d) External wall mounting brackets
(e) UL Listed Enclosure

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Perform gel and low temperature impact tests in accordance with ASTM D 1998 on condition samples cut from each polyethylene chemical storage tank.

B. Degree of Cross-linking. Use Method C of ASTM D 1998- Section 11.4 to determine the ortho-xylene insoluble fraction of cross-linked polyethylene gel test. Samples shall test at no less than 60 percent.

C. Dimensions: Take exterior dimensions with the tank empty, in the vertical position. Outside diameter tolerance, including out-of-roundness, shall be per ASTM D 1998. Fitting placement tolerance shall be +/- 1/2-in vertical and +/- 1 degree radial.

D. Visual: Inspect for foreign inclusions, air bubbles, pimples, crazing, cracking.

E. Hydrostatic test: Following fabrication, the bottom tanks, including inlet and outlet fittings, shall be hydraulically tested with water by filling to the top sidewall for a minimum of 1 hour and inspected for leaks. Following successful testing, the tank shall be emptied and cleaned prior to shipment.

3.2 DELIVERY, STORAGE, AND HANDLING

A. The tank shall be shipped upright or lying down on their sides with blocks and slings to keep them from moving. AVOID sharp objects on trailers.

B. All fittings shall be installed and, if necessary, removed for shipping and shipped separately unless otherwise noted by the contractor.

C. Upon arrival at the destination, inspect the tank(s) and accessories for damage in transit. If damage has occurred, Poly Processing Company shall be notified immediately

3.3 INSTALLATION

A. Install the tanks in strict accordance with Poly Processing Company’s Tank Installation Manual and shop drawings.

B. Installation will be inspected by manufacturer to verify system flexible connections, venting and fittings are properly installed. In addition to on-sight inspection tank system(s) to be reviewed using tank manual check list as supplied by manufacture as listed below.

C. Manufacturer to provide 1 hour training session to prepare operators to service and maintain the tank system. Included in training session will be (#) training manuals.

D. Manufacturer’s trained technician to do an onsite inspection of installation. Inspection will verify chemical application, plumbing connections, venting, and applicable ancillary equipment such as ladders, restraints, etc. A verification of proper installation certificate will be supplied when equipment passes installation checklist.

E. Tank manuals will consist of installation check lists, tank drawing(s) as built, fitting drawings referencing nozzle schedule on tank drawing, materials of construction, and recommended maintenance program.

3.4 FIELD TESTING

A. All tanks shall be hydro-tested in field for 24 hours prior to commissioning. Test should include the tank and all attached pipelines that will handle fluid (feed pipe, discharge pipe). All nozzles and connections shall be field tested to verify water tightness.

END OF SECTION 434144

SECTION 437600 – DIGESTER GAS SAFETY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish and install gas handling equipment for the anaerobic sludge digesters and the sewage gas piping system and all appurtenant work, complete and operable, including condensate and sediment traps, drip traps, flame arresters, flame traps, flame check, pressure relief/flame trap, pressure and vacuum relief valves, foam separator, and waste gas burner in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein, are specified in Section 014200 – Reference Standards.

1. ANSI/NFPA 70 - National Electric Code

B. Commercial Standards

1. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 123, 250, and 800

2. ANSI B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

1.3 CONTRACTOR SUBMITTALS

A. Prior to ordering of equipment, the CONTRACTOR shall submit shop drawings of all sludge processing equipment in accordance with Section 013300 – Contractor Submittals.

PART 2 - PRODUCTS

2.1 DRIP TRAPS

A. The drip traps shall be of a “Manual Drip Trap” style and shall have a 1” NPT inlet and outlet connections and shall be of the ball float operated needle valve type. A plug shall be provided to permit manual draining of the bowl. Construction shall be low copper aluminum body and cover. Internal working parts and fasteners shall be stainless steel.

Maximum working pressure shall be at least 5 psig. The drip trap shall be at least one (1) quart. All drip traps shall be piped to a drain, as shown on the Drawings.

B. Acceptable Manufacturers:

1. Varec Biogas,
2. Shand and Jurs,
3. Groth Corporation,
4. Or equal

2.2 FLAME ARRESTERS

A. The flame arrester shall have an ANSI class 125 flange as shown on the drawings. Housing construction shall be cast aluminum. Flame arrester net free area through the bank assembly shall be not less than three times the corresponding size standard pipe. Entire bank assembly shall slide easily out of the arrester housing to facilitate inspection and cleaning. Removing or replacing the bank assembly shall not require support for alignment, jackscrew for extending the housing, and shall not place a strain on the connecting piping. Bank frame shall be extensible and shall be filled with corrugated rectangular shaped bank sheets. Alternating flat and crimped ribbon is not an acceptable substitute. Flame arrester shall be fitted with a ½" NPT drain plug at the low point. The Contractor shall supply a ½" stainless steel ball valve, in accordance with Section 220523m "Valves," at the drain plug. Arrester housing construction shall be low copper cast aluminum. Bank assembly shall include a low copper aluminum frame and bank sheets with stainless steel hardware.

B. Acceptable Manufacturers:

1. Varec Biogas,
2. Shand and Jurs,
3. Groth Corporation,
4. Or equal

2.3 PRESSURE AND VACUUM RELIEF VALVE

A. Pressure and vacuum relief valve shall have flanged connections. Pressure relief shall be set at 15" WC. Capacity shall be not less than 4,000 SCFH digester gas of 0.8 s.g. at 4" WC overpressure. Vacuum relief shall be set at 2" w.c. Capacity shall not be less than 4,000 SCFH digester gas of 0.8 s.g. at 1" w.c. under pressure.

B. Valve pressure and vacuum ports shall be oversized to keep overpressure to a minimum. Pallets and seat rings shall be replaceable and interchangeable. Pallets shall be dead

weight loaded, and both center and side guided for stability. They shall incorporate replaceable “air cushion” Teflon seat inserts. HDPE protective screens shall be provided at the pressure and vacuum ports, located external of the pallets.

C. The valve body and cover shall be low copper cast aluminum construction. Spun hood, seat rights, and pallet assemblies shall be low copper aluminum. Guideposts shall be 304 stainless steel. Flanges shall be drilled ANSI 125 FF Flanged dimensions.

D. Acceptable Manufacturers:

1. Varec Biogas,

2. Groth Corporation,

3. Shand and Jurs,

4. Or equal

2.4 SAFETY SELECTOR VALVE

A. The valve design shall prevent the possibility of leaving the digester unprotected at any time during the switch-over of the operating Pressure and Vacuum Relief (PVR) Valve and Flame Arrester Assembly.

B. Valve shall have built in seat equalization. This is defined as the pressure being uniform and equalized across the SSV seat during changeover to facilitate the changeover process. During changeover pressure shall be applied to both sides of the seating surface. Valves in which pressure is applied to only one side of the seating surface during changeover shall not be allowed. No special tools shall be required to operate the unit. The SSV shall require no more than 80 foot-pounds of torque to equalize the seat. Units requiring more than 80 foot-pounds shall be supplied with explosion proof electric actuators.

C. There shall be means to accommodate a locking device shall be provided to prevent unwanted access to either of the Pressure and Vacuum Relief (PVR)Valve and Flame Arrester Assembly.

D. The SSV shall have a pressure drop through the active device of not greater than 3% of the flow with the pressure relief valve fully open. Valve design shall have Cv values which are verified in an ASME certified flow test facility. Testing shall have been witnessed by an ASME observer and test reports shall be supplied as part of the submittal process. Cv shall, at a minimum, be as defined in the following table:

Size	Cv
2”	225
3”	612
4”	1061
6”	2713
8”	4512

E. Packing design shall be tested to ASTM E427, Method A Halogen Leak Test, to reduce the possibility of fugitive emissions.

F. The SSV shall come with threaded ports on both process sides. The threaded ports shall come with 1" manual hand valves constructed in stainless steel. This will allow pressure testing of each process side and subsequently allow field testing and calibration of the Pressure and Vacuum Relief Valve and Flame Arrester.

G. The Safety Selector Valve shall be rated for a minimum pressure of 15 psig at 100 degrees F and shall be rated for a maximum temperature of 400 degrees F. The unit shall come with ANSI 150 FF Flanged Connections.

H. Material shall be as follows: Body, Base: Aluminum; Rotor, Indicator and Seat: 316 SS; Isolation Disk, Index Shaft, Retraction Bushing: 1704 stainless steel; Body/Base Nut and Process Connection Nut: SA194-8M stainless steel; Body/Base Stud and Process Connection Stud: SA193-B8M stainless steel; Soft Goods: Teflon.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: All gas handling equipment shall be installed in strict accordance with the manufacturer's printed recommendations.

B. Upon completion of the installation, each piece of equipment and each system shall be tested for satisfactory operation without leakage, excessive noise, vibration, overheating, etc. All equipment must be adjusted and checked for misalignment, clearance, supports, and adherence to safety standards.

END OF SECTION 437600

SECTION 437720 - DIGESTER GAS WASTE GAS BURNER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies equipment required to burn raw, wet, unconditioned biogas from anaerobic digesters. Equipment shall include the candle-stick flare and include automatic pilot ignition equipment.

1.2 RELATED WORK

A. Section 033000 – Cast-in-place Concrete

B. Section 221060 – Stainless Steel Pipe

C. Division 26 – Electrical

D. Division 40 – Process Integration

E. Section 437100 – Digester Gas H_2S Scrubber System

F. Section 437600 – Digester Gas Safety Equipment

1.3 SUPPLIER QUALIFICATIONS

A. The equipment supplier shall have a minimum of 5 years of experience in supply similar equipment for digester gas purification with the specified treatment and conditioning units.

1.4 QUALITY ASSURANCE

A. Qualifications of installers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

B. Basis of acceptance: The manufacturer's recommended installation procedures, when approved by the Engineer, will become the basis for inspecting and accepting or rejecting actual installation procedures used on this work.

1.5 WARRANTY

A. The waste gas burner system including all equipment, instrumentation, appurtenances, controls, and system performance, shall have a written Warranty for the lesser of 18 months from the receipt date of the complete system, or for 12 months of operating time unless otherwise specified. The warranty shall include parts and labor. The manufacturer shall provide instrumentation and

monitoring systems sufficient to verify the performance of the system in accordance with the requirements of this section.

B. Where equipment or system does not perform as required above, the equipment shall be repaired or replaced by the manufacturer at no cost to the Owner until such conditions are met.

1.6 PIPING COORDINATION

A. The supplier shall coordinate with the Contractor for the design and installation of all interconnecting digester gas and drainage piping so that the digester gas handling system functions properly. The Contractor shall furnish the Supplier with piping layouts prior to fabrication. The Supplier shall review Contractor pipe layouts and notify both the Contractor and the Engineer of any changes required to make the digester gas handling system function properly.

1.7 ENVIRONMENTAL CONDITIONS

A. The equipment to be provided under this section shall be suitable for installation in weather exposed locations at the operating wastewater treatment plant in North Salt Lake, Utah. The project site is approximately 4,260 feet above sea level. Outside ambient temperatures are expected to range between -16°F and 112 °F. The equipment will be subject to wind, rain, UV/sun exposure, snow and extending freezing conditions. All exposed gas and drain piping shall be insulated and heat traced.

1.8 SUBMITTALS

1. Submittals shall comply with the requirements of Section 013300 – Contractor Submittals.
2. Electrical wiring diagram and details.
3. Drawing and catalog information detailing all control devices in the control cabinets as well as overall panel layout interconnection diagrams and construction.

A. Foundation recommendations and anchor bolt sizing for the vessels, and seismic design calculations signed and sealed by a Utah registered P.E.

B. Supplier’s information confirming interface requirements between PLC and plant SCADA system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Proprietary products: References to specified proprietary products are used to establish minimum standards of utility and quality. Other materials may be considered by the Engineer in accordance with the provisions of Section.

B. Acceptable Manufacturers:

1. Varec Biogas,

2. Shand and Jurs,

3. Groth Corporation,

4. Or equal

2.2 DIGESTER GAS BURNER SYSTEM (FLARE)

A. The Digester Gas flare system shall be a unitized, modular system including all components for a complete and operational system.

B. The pilot system shall utilize on-site natural gas connection.

C. Design Parameters

1. Waste gas burner shall have a 4-inch size flanged waste gas connection. Burning capacity shall be not more than 22,250 CFH gas, MOP 8 4,275 CFH, of 0.8 specific gravity at 60 deg. F with 0.5" WC pressure drop. Burner shall be designed for waste gas composed primarily of methane.

D. Burner Construction

1. Burner shall be self-supporting on 150# ANSI RF flange for winds to 150 mph (242 km/h).

2. Burner shall be constructed with 304 stainless steel shroud and upper 24" (610 mm) of stack and pilot piping. Remainder of burner stack shall be mild steel. 316 SS Pilot nozzles, 316 SS thermocouple.

E. Pilot Gas Supply

1. Continuous flame nozzle shall be mounted integral to the burner and shall have a long profile flame. Pilot shall be inclined 45 degrees off vertical. Pilot flame shall extend through waste gas flow profile to ensure ignition of waste gas regardless of the flow rate.

2. Unprotected pilot shall withstand winds up to 110 mph (180 km/h) without the use of downdraft protectors, vortex vanes or other flow restricting devices.

3. Provide a waste gas burner that will allow operation using pilot gas supply pressure of 10" WC minimum to a maximum of 20" WC.

4. Waste gas burner shall operate using only one of the following pilot gases at 10" – 20" WC supply pressure:

a. Natural gas

b. Digester gas with minimum heat content of 500 BTU/cubic ft. or greater as pilot fuel.

5. Pilot gas only runs continuously when there is a demand to flare or combust waste gas, otherwise the burner remains on standby and does not continuously use pilot gas. Pilot gas and air shall be mixed and ignited at ground level, remote from the burner stack. Specifically, no component of the ignition system shall be mounted to the burner stack or shroud; nor shall heat shields be substituted to protect such devices from the heat of combustion.

F. Theory of Operation

1. The pilot ignition system shall utilize flame front technology.

a. Either a plant signal, or a pressure switch installed on the main gas line, initiates start-up sequence through the remote start contacts. The transformer sends voltage to the spark plug. This generates a flame front. The Continuous Nozzle catches the flame front establishing the pilot. The thermocouple located inside the continuous flame nozzle heats up. When it exceeds its temperature set point, the retention solenoid valve closes. Pilot ON indication comes on in the control panel.

2. LOCAL START OPERATION – In "AUTO" mode, the burner and the pilot will remain lit and will attempt re- ignition in case the pilot is lost. Ignition will continue to occur until PILOT ON indication is achieved. If the flare system fails to reignite in a set amount of Spark On attempts, the flare goes into system failure. The solenoid valves close, the blower shuts down and the System Failure Dry Contact changes state.

3. REMOTE START OPERATION - The flare system will be in standby until it receives the Remote Start Permissive signal. If the Remote Start Permissive signal is not present, the Remote Start Time Delay starts to time. Once it times out, the flare goes into stand by and waits for the Permissive signal to start up again.

G. Pilot Gas Control Components

1. The pilot gas control components shall be mounted on a stainless steel plate. The control panel will be mounted 15 feet from the waste gas burner to comply with NFPA 820.

2. Venturi must be installed between 25' and a maximum of 100' horizontal distance from the flare. The pilot gas piping from the pilot gas control components panel to the waste gas burner connection may have 45 deg. Elbows only to connect to the pilot gas connections in the burner stack. The pilot gas piping and venturi are at an incline to maximize air-gas mixing.

3. Pilot gas components include:

a. Class 1, Div. 1 Group D explosion proof solenoid valves with aluminum construction and stainless steel internals

b. Pressure gauges, 0-30 inches water column

c. Isolation Valves

d. 2” 347 stainless steel (SS) inspiriting venturi

e. Air blower

f. All tubing, piping, and threaded fasteners shall be provided in stainless steel

g. Remote Spark igniter in a NEMA 7 enclosure

H. Spare Parts: One each of the following devices, of the manufacturer, type and model installed in the system, as applicable shall be provided as a part of this scope of work and supply;

1. Thermocouple

2. Flame Safeguard module

3. Flame Signal Amplifier module

4. Pilot gas igniter

5. Complete set of fuses applicable to system operation

I. Burner Controls

1. Control panel shall include the following features:

a. NEMA 7, Explosion Proof Assembly

b. Type K Thermocouple Pilot flame monitoring

c. Status indicators for “Pilot On”, “Pilot Off”, “System Alarm”, “Retention Valve Open”, “Continuous Valve Open”, “Main Gas Line Open”, “Blower On”, “System Standby”.

d. Field adjustable set points for, Pilot purge time, Spark time, Thermocouple Hot, Re-ignition attempts, and Remote Start Time Delay

e. Heater and thermostat

f. Manual ignition button

g. SPDT dry contacts for Pilot On/Off and System Alarm

h. 120VAC, 1Ph, 60Hz power required (220-240VAC, 1PH, 50/60Hz Option)

i. 15Amp fused protection

j. Certified UL 508A

k. Provide the following sets of dry contacts to allow for monitoring of the flare system: “Pilot ON”, “System ALARM”, “System IN AUTO”.

J. Related Equipment

1. Pressure relief and flame trap assembly shall have inch size flanged connections. Valve shall be set to relieve pressure at 12" WC. Capacity shall be not less than 20,000 SCFH gas of specific gravity of 0.8 at 0.5" WC pressure increase above setting. A large spring loaded diaphragm shall control regulator valve. Regulator shall operate normally closed and shall maintain a back pressure within approximately 10% of the setting. The spring barrel shall include a glass-enclosed pointer and scale to indicate setting. A spring adjusting screw shall permit setting adjustments without disassembling the diaphragm housing. Construction shall be low copper cast aluminum body, diaphragm and spring housings, and diaphragm inner plate. Inner valve shall include low copper aluminum pallet with 304 SS stems and bushings. Diaphragm shall be molded Buna-N rubber with Nylon reinforcement. Setting spring shall be zinc plated steel. Valve shall include ½" NPT connections for the pressure sensing line and atmospheric vent line. Tubing provided by Contractor per the manufacturer's recommendations

   Flame arrester net free area through the bank assembly shall be not less than three times the corresponding size standard pipe. Entire bank assembly shall slide easily out of the arrester housing to facilitate inspection and cleaning. Removing or replacing the bank assembly shall not require support for alignment, jackscrew for extending the housing, and shall not place a strain on the connecting piping. Bank frame shall be extensible and shall be filled with corrugated rectangular shaped bank sheets. Alternating flat and crimped ribbon sheets are not an acceptable substitute. Flame arrester shall include an offset housing with a 1/2" NPT drain connection. Arrester housing construction shall be low copper cast aluminum. Bank assembly shall include a low copper aluminum frame and stainless steel bank sheets. The assembly shall be interconnected with a thermal bypass shut-off valve. Valve shall be the spring-actuated double acting needle type. Bypass valve shall operate within 15 seconds when the thermal element reaches 260° F (127° C). Bypass valve shall automatically close the regulator by applying full upstream gas pressure on the upper portion of the diaphragm. Fusible element shall be replaceable without disassembling the valve. By-pass valve assembly shall be constructed of aluminum and stainless steel with Buna-N "O" rings. Regulator, flame arrester, and bypass valve shall be factory assembled as a single unit. Flanges shall be drilled to ANSI 150 FF Flanged dimensions. Assembly shall be leak proof to 5 psig (34.5 kPa). Pressure relief and flame trap assembly shall be Varec Biogas 440 Series, or equal.

2. Flame Check for flame retention line, regulator vent line and pilot gas supply line shall have a compressed woven wire element design and shall utilize NPT connections. The housing shall be constructed of low copper cast aluminum. The flame arresting element shall be 316 stainless steel. Maximum working pressure shall be 25 psig. Flame check shall be Varec Series 5200, or equal.

3. Pressure Switch for Remote-Auto Start pilot capabilities A pressure switch is supplied for "REMOTE AUTO- START" capabilities. The pilot is established only when the system pressure rises to the point where biogas will be relieved to the burner for flaring, thus conserving pilot fuel. The continuous pilot heats the pilot thermocouple above its set point in the controller. The pilot alarm contacts switches to indicate that the continuous pilot is lit and up to temperature.

   a. Range: 4" to 30" (100mm to 750mm) W.C. Pressure Connection: 1/4" NPT

   b. Switch Rating: 15 amps @ 125 VAC

c. Enclosure: NEMA 7, Explosion proof, Class 1, Div. 1, Groups C & D

d. Deadband: 0.5” (28 mm) W.C. Conduit Connection: 3/4” NPT

e. Temperature Range: -80° to +180°F (-62° to +82°C)

f. Approval: UL Approved

2.3 CONTROLS AND ELECTRICAL

A. General: Controls and electrical devices and systems shall conform to the requirements of Divisions 26 and 40. All controls necessary for the manual and fully automatic operation shall be provided.

B. Instrumentation: All instruments provided by the manufacturer shall be in accordance with applicable Sections in Division 26, “Electrical,” and Division 40, “Process Integration.”

PART 3 - EXECUTION

3.1 INSTALLATION & HANDLING

A. Protection: The Contractor shall use all means necessary to protect the condition and integrity of the equipment provided under this section both during and after receipt of said equipment, and to protect the installed work and all other trades.

B. Replacements: In the event of damage during installation, Contractor shall immediately make all repairs and/or replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

C. Deliver materials in manufacturer's original packaging with all tags and labels intact and legible.

D. Store and handle material in such a manner as to avoid damage; store at site under cover if required to meet the conditions of this section.

E. General: Install the work of this section in strict accordance with the manufacturer's recommendations as approved by the Engineer.

F. Installation shall proceed in compliance with the submitted installation schedule, as approved by the Engineer.

G. The work of this section shall be installed plumb and perpendicular to piping where required on Construction Drawings.

H. Painting: Marred or abraded surfaces shall be cleaned and refinished in accordance with the manufacturer’s recommendations.

I. The supplier shall coordinate with the Contractor for the design and installation of all interconnecting digester gas and drainage piping so that the digester gas handling system functions properly. The Contractor shall furnish the Supplier with piping layouts prior to fabrication. The Supplier shall review Contractor pipe layouts and notify both the Contractor and the Engineer of any changes required to make the digester gas handling system function properly.

3.2 START-UP & TESTING

A. Factory Test: The entire system, including all controls shall be tested at the manufacturer's plant before shipment. Complete test reports shall be made available which shall show all system controls operate correctly prior to shipment.

B. Start-up: The manufacturer shall furnish his factory trained representative for a minimum of three (3) days of start-up & training labor. The representative will remain on site until start-up of the system has been completed to the engineers' satisfaction, unless failure to achieve a successful start-up is NOT the fault or cause of the manufacturer.

C. Functional and Validation Tests: Upon completion of the installation, functional and validation tests shall be performed by the Contractor with the assistance of the manufacturer's representative in accordance with Section 017500, "Commissioning". The manufacturer's representative will demonstrate compliant operation of the system to the engineer's satisfaction. Should the system NOT perform to the requirements of this specification, the expense of any re-testing, if required, will be borne by the system manufacturer, unless failure to achieve successful operation is neither the fault or cause of the manufacturer.

3.3 TRAINING

A. When all required approvals of this portion of the work have been obtained, and at a time designated by the Owner and/or Engineer, the Contractor and/or the manufacturer's representative in charge of start-up and testing shall thoroughly demonstrate to the Owners operation and maintenance personnel the operation and maintenance of all items installed under the work of this section.

B. The instructions shall be separate from the installation, start-up and equipment adjustment services.

3.4 CLEANING

A. Clean exposed surface of all grease, dirt and other foreign materials.

B. Touch up all marred or abraded surfaces as specified herein.

3.5 PAINTING

A. Surface Preparation

1. All surfaces of equipment shall be provided with the manufacturer's standard shop priming and painting system. The installing Contractor shall be responsible for field touch up coating, in accordance with Specification Section 098000, "Protective Coatings" and the manufacturer's recommendations.

END OF SECTION 437720

SECTION 462118 - MECHANICALLY CLEANED CENTER FLOW BAR SCREEN

PART 1 GENERAL

1.1 SCOPE OF WORK

A. The contractor shall furnish and install center flow type, multiple rake bar screen(s) as indicated on the drawings. Each screen shall be manufactured from AISI 304L or 316L stainless steel shapes. Fabrication and assembly shall be in conformance with these specifications and drawings.

B. Each screen shall be furnished complete with bar rack, dead plate, discharge chute, side frames, covers, rake blades, drive chains, sprockets and bearings, scraper assembly, drive motor, gear reducer, anchor bolts, controls and all accessories and appurtenances specified or otherwise required for a complete and properly operating installation.

C. The contractor shall coordinate all details of the equipment with other related parts of the work. He shall verify that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alterations required to accommodate equipment differing in dimensions, weight, or other characteristics from these specifications and drawings.

D. The contractor shall install the equipment according to instructions and recommendations of the equipment manufacturer.

E. The main power supply is 480 V, 60 Hz, 3-phase. The power supply for the air compressor shall be 120 V, 60 Hz, 1-phase.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM) Publications:

B. ISO 281:2007 Calculation Method for Fatigue Life for Roller Bearings.

C. American Institute of Steel Construction (AISC) Publications

D. American Welding Society (AWS), European Welding Federation (EWF), and International Institute of Welding (IIW) Publications

E. American Structures Painting Council (ASPC) Publications

F. International Organization for Standardization (ISO) Publications.

1.3 SUBMITTALS

The manufacturer will provide an electronic submittal for review by the engineer in accordance with Section 01300.

A. Product Data: Include the following:

1. Descriptive literature, brochures, catalogs, cut sheets and supplementary material to define the equipment.

2. Motor characteristics and performance information.

3. Gear reducer data including service factor, efficiency, torque rating, and materials.

4. Parts list including a list of recommended spare parts.

B. Shop Drawings: Include the following:

1. Manufacturer’s installation drawings.

2. Wiring and schematic diagrams.

C. Operations and maintenance manual.

D. Detailed mechanical and electrical installation instructions and procedures.

E. Equipment weights and lifting points.

F. Recommendations for short and long-term storage.

G. A copy of the manufacturer's warranty.

H. A copy of documents proving certification of the Manufacturer's Quality Management System according to ISO 9001 and Environmental Protection Management System according to ISO 14001.

I. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

1.4 QUALITY ASSURANCE

A. To ensure quality, conformance, reliability, and environmental practices with regard to the manufacturing and production of the machinery described in this section, the equipment manufacturer shall meet the requirements listed in this section.

B. Manufacturer shall have established an ISO 9001 certified quality management system. Manufacturers without an ISO 9001 certified quality management program must provide complete documentation of their existing quality management system with supplemental information clarifying why areas do not meet ISO 9001 standards. Meeting national quality management standards alone shall not be considered an acceptable substitute because ISO standards exceed national quality management standards.

C. Manufacturer shall have established an ISO 14001 certified environmental protection management system. Manufacturers without an ISO 14001 certified environmental protection management system must provide complete documentation of their existing environmental protection management system with supplemental information clarifying why areas do not meet ISO 14001 standards. Meeting national or local environmental protection management standards alone shall not be considered an acceptable substitute because ISO standards exceed national and local environmental protection management standards.

D. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material because of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer, which is critical to the long life of the stainless steel.

E. No stainless-steel components may be fabricated or assembled in a factory where carbon steel products are fabricated, in order to prevent contamination by rust.

F. The manufacturer shall have a minimum of twenty (20) years' experience producing multi-rake screens and upon request will submit to the engineer documentation of fifteen (15) installations similar or larger than specified herein, that have been in operation for at least five (5) years

G. All welding is performed in accordance with American Welding Society (AWS), European Welding Federation (EWF), International Institute of Welding (IIW), or equivalent.

H. Manufacturer shall provide screen, motors, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

I. Manufacturer shall provide services by a factory-trained service technician, specifically trained on the type of equipment specified. Service technician requirements include, but are not limited to the following:

1. Manufacturer shall have a minimum of ten (10) service technicians based in the United States for field service of the equipment. Manufacturer shall have multiple service locations with a minimum of one dedicated service location for both the eastern and western regions of the US.
2. Service technician shall be present during initial energizing of equipment to determine directional testing.
3. Service technician shall inspect and verify location of anchor bolts, placement, leveling, alignment and field erection of equipment, as well as control panel operation and electrical connections.
4. Service technician shall provide classroom and/or field training on the operation and maintenance of the equipment to operator personnel.
5. Manufacturer shall state field service rates for a service technician to owner and contractor. In the event that the field service time required by this section should not be sufficient to properly place the equipment into operation, additional time shall be purchased by contractor to correct deficiencies in installation, equipment, or material without additional cost to owner.

J. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or installation, defective workmanship or materials, and breakage or other failure. Materials shall be suitable for service conditions.

K. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service prior to delivery, except as required by testing.

L. Each major component of equipment shall have the manufacturer's name, address and product identification on a nameplate securely affixed to the equipment.

1.5 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT

A. Equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

B. Contractor shall be responsible for unloading and shall have equipment on-site at the time of delivery permitting proper hoisting of the equipment.

1.6 PRE-SUBMITTAL OF ALTERNATE EQUIPMENT

Manufacturers of alternative equipment shall submit a pre-approval package to the engineer at least two (2) weeks prior to bid date. Alternative manufacturers shall submit the following information and supporting documentation:

A. A complete set of drawings, specifications, catalog cut-sheets, and detailed descriptive material. Drawings shall show all relevant details of the unit. This information shall identify all technical and performance requirements stipulated on the drawings and in the specification. If the proposed equipment does not meet these specifications, any deviation from the specification must be expressly noted. All deviations shall be listed on a single document.

B. Detailed installation drawings illustrating how the proposed screw press will be installed. The drawings shall include plan, elevation, and sectional views of the installation. Drawings shall include details of the injection ring, mixing valve, flocculation reactor, and details of the anchor bolt locations.

C. Structural calculations by a Professional Engineer either confirming the existing structural design is sufficient for the alternate equipment or detailing any changes required for the building design to use the alternate equipment.

D. Motor characteristics and performance information. Vendor data shall be furnished to confirm the torque and thrust rating of the drives.

E. Complete reference list of all installations of same and similar equipment including contact names and phone numbers, showing at least 20 municipal installations of the same size as the alternate equipment located in the United States.

F. Complete bill of materials for all equipment, showing dimensions and materials of construction of all components.

G. Certification by the manufacturer that all stainless-steel equipment will be manufactured in a stainless steel only factory.

H. Certification that the entire equipment will be passivated by submersion in an acid bath as specified in chapter 2.03.

I. A copy of documents proving certification of the Manufacturer's Quality Management System according to ISO 9001. Manufacturers without an ISO 9001 certified quality management program must provide complete documentation of their existing quality management system with supplemental information clarifying why areas do not meet ISO 9001 standards. Meeting national quality management standards alone shall not be considered an acceptable substitute because ISO standards exceed national quality management standards.

J. A copy of documents proving certification of the Environmental Protection Management System according to ISO 14001. Manufacturers without an ISO 14001 certified environmental protection management system must provide complete documentation of their existing environmental protection management system with supplemental information clarifying why areas do not meet ISO 14001 standards. Meeting national or local environmental protection management standards alone shall not be considered an acceptable substitute because ISO standards exceed national and local environmental protection management standards.

K. Details of the control and instrumentation system including wiring diagrams. A Professional Engineer shall note any required changes to the project electrical drawings.

L. Information on equipment field erection requirements including total weight of assembled components and weight of each sub-assembly.

M. List of recommended spare parts and current cost of each spare part.

N. A maintenance schedule showing the required maintenance, frequency of maintenance, lubricants and other items required at each regular preventative maintenance period, including all ancillary equipment provided.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. RakeMax-CF Model 4873x900x1125/6 from HUBER Technology, Inc.

B. Center-Flow Type Traveling Multi-Rake Screen from pre-approved alternate manufacturer(s), as per section 1.06 above.

Alternates shall not be acceptable unless pre-approved. Costs for changes in design to accommodate alternative offers shall be borne by the alternate screen provider.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

Parameter	Value
Location in Facility	New Headworks Building
Number of Units	2
Approach Channel Width [ft]	4.00
Channel Width at Screen Location [ft]	6.00
Channel Depth [ft]	17
Channel Invert to Operating Deck [ft]	17
Equipment Location [Indoor/Outdoor]	Indoor
Installation Area Classification	Class I Division I
Peak Hourly Flow (per Screen) [MGD]	24.00
Average Daily Flow (per Screen) [MGD]	-
Downstream Water Level During PHF [in]	34
Downstream Water Level During ADF [in]	-
Maximum Upstream Water Level [in]	52
Maximum Headloss During PHF* [in]	14
Minimum Freeboard [in]	90
Chamber Opening [in]	35.43 (900mm)
Bar Grid Depth (Parallel with Channel) [in]	44.3 (1125mm)
Clear Spacing Between Screening Bars [in]	0.25 (6mm)
Minimum Bar Dimensions (Rectangular Profile) [in]	0.16 x 0.75
Inclination from Horizontal within Channel [degrees]	90
Discharge Height Above Channel Invert [ft]	16.09
Minimum Motor Rating [HP]	2.0

*Based on 30% blinding of the screen field.

1. The travel speed of the rakes shall be between 26 and 39 feet per minute (8 to 12 m/min).
2. All parts shall be designed and manufactured to handle the forces that may be exerted on the screen during fabrication, shipping, erection, and proper operation according to the O&M manual.
3. All components shall be so designed that jamming at any point will not result in structural failure but will cause the drive motor to stall. All components, including the gear reducer, shall be designed to withstand, without damage or permanent distortion, the full stalling torque of the drive motor and/or the maximum differential head at any channel water depth.

2.3 BAR SCREEN DESIGN SPECIFICATIONS

A. MATERIALS

Frame, Dead plate, Chain Guides & Discharge Chute	304L Stainless Steel
Screening Bars & Rakes	304L Stainless Steel
Screen Covers	304L Stainless Steel
Drive Chain Links	316L Stainless Steel
Drive Chain Pins & Bushings	AISI-431 Stainless Steel
Drive Chain Rollers	Polyamide
Drive Shaft & Sprockets	304L Stainless Steel
Wiper Blade	Polyethylene
Channel Seals	EPDM

*Unless otherwise noted.

1. Screen shall be manufactured from shapes (rods, angles, and channels), pipes, and sheets from stainless steel material as noted in the table above.
2. Screen shall be manufactured in a stainless steel only factory to prevent contamination of the stainless steel with rusty dust.
3. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Sand blasting, bead blasting, spray pickling or hand pickling of stainless-steel surfaces shall not be acceptable
4. Upper sprocket bearings shall have a paint coated cast iron casing and include ball bearings with grease nipples that are double sealed with Nilos rings.

B. CONSTRUCTION

1. The fine screen herein specified will be of the center flow type. The flow enters the inside of the screen's chamber opening and exits through both vertical sides and the bottom of the stationary screening bars. Screen designs that are not center flow type or screens utilizing rotating, continuous belts of plates, links or other screening media will not be acceptable for this project.
2. The bar screen shall remove debris (screenings) from the incoming wastewater by means of a positively cleaned U-shaped bar rack that is installed within a concrete channel. The screen shall retain debris at the bar rack. A multitude of rake blades shall remove and lift the debris to a discharge mechanism. The bar rack shall be cleaned by a series of rakes engaging the bar

rack starting above the maximum upstream water level and continuously engaging within the screening bars while moving along the entire bar rack length. The debris shall be lifted vertically above the operating deck elevation, transferred to a 70° screen section before dropped on a discharge chute to the side of the screen (parallel to influent flow).

3. Screens with single rakes shall not be approved. Screens employing brushes and spray water for screenings removal shall not be approved. Screens centrally discharging within the chamber opening width (above the channel) to an internal sluice, conveyor or press shall not be approved. Screens that engage the rakes into the screening bars below the water level shall not be approved as they are susceptible to jams and/or damaged rake teeth.

4. The bar rack shall consist of equally spaced bars that are formed from a continuous length of stainless steel. The bar rack shall have a "U" shaped profile to accommodate the center flow screen design over the entire bar grid depth as specified herein. Individual bars shall have a rectangular cross section with a width of 5/32" (4 mm), a depth of minimum 0.75" (20 mm). Round, tear-shape or trapezoidal bar shapes will not be acceptable. The bar rack shall be made up of equally sized sections securely fastened to the frame of the screen and be readily removable. Screens without the ability to replace bar screen sections will not be acceptable for this project.

5. A frame shall be provided supporting all required loads. Front and rear shell frames shall be made of 10/64 inch (4 mm) thick stainless-steel plates with a minimum of four axial edges. The shell frames shall be connected with each other through channels having a minimum thickness of 10/64 inch (4 mm) and a minimum cross section of 4-1/4 inch x 2 inch (108 x 49 mm). The shell frames shall be connected to extended support brackets to reach the side channel walls. The support brackets shall be securely anchored onto the operating floor.

6. The bar screen shall be provided with a dead plate extending from the bar rack to the discharge chute, positioned parallel with the incoming flow. The dead plate shall be made of 10/64 inch or 4 mm thick stainless-steel plate and shall be stiffened by structural members so that it is flat without undulation so that the tips of the rake's teeth ride at a distance between 1 to 2 mm over the dead plate. Upper portion of the dead plate shall incorporate a rounded transition from 90° to 70° prior to the discharge point. The dead plate shall be securely fastened to the front and rear shell frames.

7. The back-plate of the screen shall be furnished with modular overflow weir plates that provide a stationary overflow weir for emergencies. The upper plates shall be bolted to the shell frames and set just above the maximum upstream water level. Screen designs that do not incorporate a fixed emergency overflow option will not be acceptable for this project.

8. A discharge chute shall be provided that fully encloses the discharge section of the screen. An access hatch with hinges and a handle shall be provided in the chute permitting easy access. The discharge chute shall be mounted to direct screenings into the appropriate receiving washer/compactor, sluice, conveyor or screenings bin. The chute shall have a slope of minimum 60 degrees. The discharge chute shall be made of a minimum 10/64 inch or 4 mm thick stainless-steel plate.

9. The screen shall be provided with easily removable, sufficiently stiffened covers made of 3/64 inch (1.5 mm) thick stainless-steel plates with edges on all sides. The covers shall be provided with turn locks and handles.

10. If influent channel width is greater than the chamber opening, two (2) stainless steel baffle plates shall be included and bolted to the front of the screen and anchored to the concrete channel to direct the influent flow into the chamber opening. The baffle plates shall be formed from minimum 13-gauge material and set at minimum 45° to reduce headloss through

the reduction and shall match the height of the overflow weir plate within the screen to provide additional weir length for emergencies.

11. Each shell frame shall include separate roller tracks to guide the rakes. The roller tracks shall be bolted to the frame so that they can easily be replaced. The roller tracks shall be made of minimum 10/64 inch (4 mm) thick L-profiles.

12. Drive chains for the rakes shall be roller type. Each chain shall be rated for a maximum load of 112,000N (25,178lbs. f). Drive chains, chain guides, sprockets and their bearings shall be replaceable without the need for removing the screen from the channel. Chain pitch shall be no less than 6-5/16 inch (160mm). Screens utilizing drive chains constructed from alternative materials will not be acceptable for this project due to the corrosive nature of wastewater.

13. Chain rollers shall have a diameter of 2-3/8 inch (60 mm) and shall be a minimum of 1-1/4 inch (32 mm) wide.

14. Each screen shall be provided with two upper sprockets with a reference diameter of 17-3/8 inch (442 mm). The sprockets shall be split to facilitate maintenance. The sprockets shall be made of minimum 1-1/8 inch (29 mm) thick stainless-steel plates. Screen designs that utilize sprockets constructing of differing materials will not be acceptable for this project. Screens that utilize submerged bottom sprockets or guide discs will not be acceptable for this project.

15. Upper bearings shall be flange bearings and shall be provided with grease nipples for easy lubrication. The bearings shall be designed for use with biodegradable grease. Their diameter shall be a minimum of 2 inch (50mm). The casing shall be made of paint coated cast iron.

16. Rakes shall include rake bars made of 1/4 inch (6 mm) thick channel profile having a cross section of 8-1/4 inch x 3 3/8 inch (210 x 85 mm). Curved rake blades with a thickness of 13/64 inch (5 mm) and a depth of minimum 5-1/2 inch (140 mm) shall be bolted on the rake bars. Rake blades shall be set at an obtuse angle to that of the screening bar face to prevent screenings push-through or jams. The rake blades and reinforcing rake shall have teeth matching and engaging the bars of the bar rack. Reinforcing rake blade teeth shall be formed from minimum 3/8" (10 mm) thick stainless steel and welded to the underside of each rake blade. Individual rake blade teeth shall have a minimum depth of 3/4 inch (20 mm) to ensure full engagement with a tolerance width of 1 mm between the screening bars to provide optimal cleaning. Reinforcing rake teeth shall have a minimum 1.5 mm tolerance width.

17. A pivoting scraper mechanism shall be positioned at the point of discharge and shall be attached to the shell frames. The scraper shall clean the rake on each pass and return to its rest position with minimal shock. The scraper shall be designed such that screenings do not wrap around the rake or scraper. The scraper shall be provided with a scraper bar made 10/64 inch (4 mm) thick channel profile with a minimum cross section of 1-1/2 inch x 2-11/16 inch (39 x 68 mm) and an adjustable 3/8 inch (10 mm) thick blade. The scraper shall be connected with the frame through a pair of minimum 20 inch (500 mm) long scraper arms that shall be made of 10/64 inch (4 mm) thick channel profile with a minimum cross section of 2-3/4 inch x 2-3/8 inch (68 x 59 mm). A pair of shock absorber elements made of EPDM shall be provided.

18. The drive shaft shall be hollow and have a diameter of minimum 3-1/8 inch (80mm) and a wall thickness of minimum 13/64 inch (5 mm). Solid drive shafts shall not be accepted.

19. The drive-mounted rocker arm assembly shall consist of a drive unit mounted to a stainless-steel arm. The stainless-steel arm will be held in place by a flanged roller bearing connected to the drive shaft and two heavy duty tension springs. The flange bearing shall be connected to the rocker arm by four bolts. The rocker arm position shall be maintained in the standard

operating position by the two tension springs. An intrinsically safe proximity switch shall indicate the position.

20. The drive unit shall be designed for continuous service and intermittent spray water contact.
21. The bevel gear reducer shall be a totally enclosed unit. Gear reducer shall have ball or roller bearings throughout with all moving parts immersed in oil. Gear reducers which require periodic disassembly of the unit and manual re-greasing of bearings are not acceptable. The nominal input power rating of the gear reducer shall be at least equal to the nominal horsepower of the drive motor. Gear reducer shall be designed and manufactured in compliance with applicable AGMA or equivalent standards. During continuous operation the oil temperature shall not exceed 200 degrees F (95 degrees C).
22. The rake assembly shall be driven by an electric motor. The motor shall be UL rated for operation in Class 1 Division 1 environment. The motor shall be inverter duty rated, 460 Volts, 60 Hz, 3-phase. The motor shall be rated for operation in a 104 degree F (40 degree C) environment.

2.4 CONTROLS AND INSTRUMENTATION

A. GENERAL

1. The control system shall be provided by the screen supplier.

B. LOCAL CONTROLS ON EACH SCREEN

1. One (1) NEMA7, Class I Division I approved Cast Aluminum local control station per screen.

C. WATER LEVEL SENSORS

1. Bar screen manufacturer shall provide two (2) VEGAPULS C21 radar sensors for continuously monitoring of the upstream and downstream water levels for control of screen operation. The sensors shall be rated for hazardous locations and shall be intrinsically safe without the use of additional barriers. Contractor shall install the sensors and provide wiring to the control panel.

D. CONTROL PANEL

1. A single main control panel shall be furnished with a lockable NEMA 4/12 painted steel enclosure together with a single local push button station rated for a NEMA 7, Class I Division I environment.

2. Control panel shall meet the requirements of specification division 40 as applicable

3. Controls panel shall be made by a U.L. listed company and shall bear a U.L. label.

4. Control panel wiring shall be color coded, neatly cabled and supported in non-flammable wiring tracks. Wiring shall be minimum 14-gauge MTW stranded wire.

5. Control panel shall contain all power and control devices necessary for the proper function of the screen and shall include the following:

a. 600-Volt rated main circuit breaker disconnect with lockable handle

b. 480 – 120 Volt control power transformer

c. Reversible Screen VFD, Square D Altivar 31 or approved equal

d. HAND-OFF-AUTO selector switch for the operation of the bar screen drive

e. FORWARD-OFF-REVERSE selector switch for HAND operation. Switch shall spring return from REVERSE to OFF

f. Red pilot light for "Screen Run" indication

g. Amber pilot light for "Fault" indication

h. Amber pilot light for "High Water Level" indication

i. White pilot light for "Control Power" indication

j. Alarm silence and reset push buttons

k. Push-to-Stop/Pull-to Run emergency stop maintained push button with lockout

l. Dry contacts for remote indication of "Fault", "Screen Running", and "High Level"

m. Control relays, wiring and circuitry required to implement the control logic

n. High Level Float switch

o. Programmable controller (PLC) Modicon M340 or approved equal

p. Operator interface Modicon Magellis 6" or approved equal:
   1. Display of current fault
   2. Alarm History
   3. Motor Hour Meter
   4. Operator access to user adjustable setpoints

E. SEQUENCE OF OPERATION

1. In AUTO position the screen shall be controlled by the water level sensors. Screen operation shall be started when the water level sensors monitor a certain water level difference, when the ultrasonic level sensor detects high water level, or when a certain time has passed since the last operation of the screen. Screen operation shall be stopped with an adjustable delay time after the water difference is below a certain value and after the ultrasonic level sensor ceases to indicate high water alarm, or after a certain run time has expired (if operation was started by timer).
2. Reset is manually performed after correction of any cause for a trip-out.

3. In HAND position the operator shall be able to run the rake assembly selecting the respective FORWARD or REVERSE direction from the FORWARD-OFF-REVERSE selector switch.

PART 3 SPARE PARTS

3.1 SPARE PARTS

A. The following spare parts shall be included and supplied with the equipment:

1. Two (2) wipers for scraper
2. Two (2) proximity switches

B. Spare parts shall be packaged with labels including a description of the contents.

PART 4 EXECUTION

4.1 INSTALLATION, START-UP, AND OPERATOR TRAINING

A. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify engineer of significant deviations.

B. Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply anchor bolts for the equipment. Contractors shall install the anchor bolts in accordance with the manufacturer's recommendations.

C. After installation, touch-up paint shall be applied to all scratched, abraded, and damaged shop painted surfaces. Coating type and color shall match shop painting. Contractor shall passivate all field welds.

D. Supplier shall furnish the services of a factory-trained service technician for one (1) trip including a total of two (2) workdays to inspect the installation, observe start up, and provide operator training.

1. Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the service technician present.

2. The service technician shall make all necessary adjustments and settings to the controls.

3. The service technician shall demonstrate proper and sequential operation of the screening system. The screen shall be able to operate fully automatically.

4.2 WARRANTY

A. The manufacturer will warrant against any defects in material or workmanship to the screen and framework. This warranty will commence upon delivery of the products and will expire on the earlier to occur of one (1) year from initial operation of the product or 18 months from delivery thereof (the "Warranty Period").

END OF SECTION 462118

SECTION 462173 - SCREENINGS WASHER COMPACTOR

PART 1: GENERAL

1.1 SCOPE

A. Contractor shall furnish and install screenings wash and press(es) (WAP) for washing, dewatering, compacting and conveying screenings material as shown on the drawings and described in the specifications. Each WAP shall be manufactured from stainless steel shapes. Fabrication and assembly shall be in conformance with these specifications and drawings.

B. Each WAP shall include a cylindrical body, shafted auger, gear motor, wash water manifold with solenoid valve(s), anchor bolts, controls and all accessories and appurtenances specified or otherwise required for a complete and properly operating installation.

C. The contractor shall coordinate all details of the equipment with other related parts of the work. He shall verify that all structures, piping, wiring, and equipment components are compatible. The contractor shall be responsible for all structural and other alterations required to accommodate equipment differing in dimensions, weight, or other characteristics from these specifications and drawings.

D. The contractor shall install the equipment according to instructions and recommendations of the equipment manufacturer.

E. The main power supply is 480 V, 60 Hz, 3-phase.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM) Publications

B. ISO 281:2007 Calculation Method for Fatigue Life for Roller Bearings

C. American Institute of Steel Construction (AISC) Publications

D. American Welding Society (AWS), European Welding Federation (EWF), and International Institute of Welding (IIW) Publications

E. American Structures Painting Council (ASPC) Publications

F. International Organization for Standardization (ISO) Publications

1.3 SUBMITTALS

The manufacturer will provide an electronic submittal for review by the engineer in accordance with Section 01300.

A. Product Data: Include the following:

1. Descriptive literature, brochures, catalogs, cut-sheets and supplementary material to define the equipment.

2. Motor characteristics and performance information.

3. Gear reducer data including service factor, efficiency, torque rating, and materials.

4. Parts list including a list of recommended spare parts.

B. Shop Drawings: Include the following:

1. Manufacturer's installation drawings.
2. Wiring and schematic diagrams.

C. Operations and maintenance manual.

D. Detailed mechanical and electrical installation instructions and procedures.

E. Equipment weights and lifting points.

F. Recommendations for short and long-term storage.

G. A copy of the manufacturer's warranty.

H. A copy of documents proving certification of the Manufacturer's Quality Management System according to ISO 9001 and Environmental Protection Management System according to ISO 14001.

I. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

1.04 QUALITY ASSURANCE

A. To ensure quality, conformance, reliability, and environmental practices with regard to the manufacturing and production of the machinery described in this section, the equipment manufacturer shall meet the requirements listed in this section.

B. Manufacturer shall have established an ISO 9001 certified quality management system. Manufacturers without an ISO 9001 certified quality management program must provide complete documentation of their existing quality management system with supplemental information clarifying why areas do not meet ISO 9001 standards. Meeting national quality management standards alone shall not be considered an acceptable substitute because ISO standards exceed national quality management standards.

C. Manufacturer shall have established an ISO 14001 certified environmental protection management system. Manufacturers without an ISO 14001 certified environmental protection management system must provide complete documentation of their existing environmental protection management system with supplemental information clarifying why areas do not meet ISO 14001 standards. Meeting national or local environmental protection management standards alone shall not be considered an acceptable substitute because ISO standards exceed national and local environmental protection management standards.

D. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material because of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer, which is critical to the long life of the stainless steel.

E. No stainless-steel components may be fabricated or assembled in a factory where carbon steel products are fabricated, in order to prevent contamination by rust.

F. Manufacturer shall have a minimum of twenty (20) years experience producing equipment substantially similar to that required and shall be able to submit documentation of at least fifty (50) independent installations using the same type of equipment as detailed below. Each installation must have been in satisfactory operation for at least five (5) years.

G. OEM: Manufacturer shall provide evidence of Original Equipment Manufacturer (OEM) of the specified wash and press design and manufacturing. Licensed wash and press designs shall not be accepted.

H. All welding is performed in accordance with American Welding Society (AWS), European Welding Federation (EWF), International Institute of Welding (IIW), or equivalent.

I. Manufacturer shall provide screen, motors, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

J. Manufacturer shall provide services by a factory-trained service technician, specifically trained on the type of equipment specified. Service technician requirements include, but are not limited to the following:

1. Manufacturer shall have a minimum of ten (10) service technicians based in the United States for field service of the equipment. Manufacturer shall have multiple service locations with a minimum of one dedicated service location for both the eastern and western regions of the US.
2. Service technician shall be present during initial energizing of equipment to determine directional testing.
3. Service technician shall inspect and verify location of anchor bolts, placement, leveling, alignment and field erection of equipment, as well as control panel operation and electrical connections.
4. Service technician shall provide classroom and/or field training on the operation and maintenance of the equipment to operator personnel.
5. Manufacturer shall state field service rates for a service technician to owner and contractor. In the event that the field service time required by this section should not be sufficient to properly place the equipment into operation, additional time shall be purchased by contractor to correct deficiencies in installation, equipment, or material without additional cost to owner.

K. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or installation, defective workmanship or materials, and breakage or other failure. Materials shall be suitable for service conditions.

L. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service prior to delivery, except as required by testing.

M. Each major component of equipment shall have the manufacturer's name, address and product identification on a nameplate securely affixed to the equipment.

1.05 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT

A. Equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

B. Contractor shall be responsible for unloading and shall have equipment on-site at the time of delivery permitting proper hoisting of the equipment.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Base Bid: WAP Size 4 from HUBER Technology, Inc.

B. Equipment of all manufacturers must be in accordance with these specifications and plans. Being named as a manufacturer does not eliminate their responsibility of providing equipment in compliance with the following specification section. Any deviations without sufficient evidence proving equal or superior quality shall be rejected without further review or comment.

2.02 PERFORMANCE REQUIREMENTS

Parameter	Value
Number of Units	2
Feed Type	Screen
Equipment Location [Indoor/Outdoor]	Indoor
Installation Area Classification	Class I Division I
Maximum Screenings Capacity [ft^3/hr]	140
Optimal Screenings Throughput [ft^3/hr] *	53-88
Maximum Moisture Content of Dewatered Screenings	65%
Wash Water Demand [gpm]	16
Wash Water Pressure [psi]	30-75
Minimum Drive Motor Rating [HP]	5.0

*For best performance and final product

A. The equipment specified herein shall be standard equipment manufactured for use in a municipal wastewater treatment plant, specifically to reduce and separate fecal matter from raw sewage screenings.

B. The screening equipment shall produce dewatered screenings capable of passing the EPA Paint Filter Test as described in method 9095 of EPA Publication SW-486.

C. To minimize odors and nuisance, the conveyance, dewatering and compaction zones shall be completely enclosed.

D. The spray wash system shall be enclosed such that spray water, aerosols or leakage do not contaminate the operating floor.

E. The washer compactor shall include a bagging system for the discharge chute. The bag shall be 1.3 mil polyethylene and shall be sized to fit over the discharge chute.

F. The control system shall be designed such that the cleaning characteristics of the wash and press system can be changed via the programmable controller. Systems which do not offer this feature will not be acceptable for this project.

2.03 PRODUCT DESIGN SPECIFICATIONS

A. MATERIALS

Washer/Compactor Body	304L Stainless Steel
Shafted Screw Auger	304L Stainless Steel
Inlet Hopper	304L Stainless Steel
Discharge Pipe	304L Stainless Steel
Guide Bars	Hardox 400 Plate
Flight Brushes	Nylon
Solenoid Valve(s)	Brass Bodied

*Unless otherwise noted.

B. SCREENINGS WASHER BODY

1. The WAP 4 screenings washer body shall be fabricated from 1/8” (3 mm) thick stainless steel. The 10-3/4” (273 mm) diameter screenings washer body shall include a nominal 47-1/4” x 11-3/4” (1200 mm x 300 mm) trough opening for screenings deposit. A level mounting flange shall be provided around the trough for the transitional hopper that directs the screenings into the trough of the screenings washer. The hopper shall be fabricated from 3/32” (2.5 mm) thick stainless steel.

2. The screenings washer body shall house the shafted screw, and shall include one (1) 3/4" diameter wash water connections in the compaction zone, one (1) 3/8” diameter connection in the screenings trough, and shall include one (1) connection to the drain pan to flush any debris from the drainage pan.

3. The screenings washer body shall include 3/16” (5 mm) diameter perforations spaced 13/32” (10 mm) center-to-center in a vertical alignment in the washing and compaction zones to drain the excess wash water and filtrate water pressed from the screenings to the drain pan. Designs utilizing larger openings or wedge wire drains shall not be acceptable.

4. The screenings washer body shall be equipped with not less than six (6) guide bars. The guide bars shall be bolted from the outside of the tube for easy access and removal. The guide bars shall be at least 14-1/2” (370 mm) long and the thickness shall be not less than 1/4” (6mm). Welded guide bars shall be not allowed.

C. SHAFTED SCREW

1. The shafted screw shall transport the screenings from the trough area (washing zone) into the compaction zone and shall force the compacted screenings out the discharge pipe. The shafted screw for the WAP 4 shall be fabricated from 3/16” (5 mm) thick stainless steel.

2. The screw flights shall have a minimum thickness of 13/32” (10 mm) in the trough and perforated washing zones, and a thickness of 25/32” (20 mm) in the compression zone. The outside diameter of the screw shall be 10-3/16” (259 mm) and shall include a 6” (150 mm) flight pitch in the trough area and washing zone, and a 4-3/4” (120 mm) pitch in the compaction zone.
3. Screw flights in the compaction zone shall have a Hardox 400 abrasion resistant plate welded to the stainless steel flights. The last flight of the screw shall have Tubrodur hard metal seams welded around the external surface of the flight.
4. A stainless steel backed brush shall be attached to the shafted screw with set screws for the full length of the perforated washing zone. Brush segments fit in manufactured groove on the trailing edge of the flights. Designs that do not utilize brushes to clean the sieve or mount the brushes on the leading edge or top of the flights shall not be acceptable.

D. PLANT WATER MANIFOLD

1. The screenings washer shall be equipped with a manifold to provide plant water to the different washing inlet locations. The manifold shall be mounted directly to the top discharge end of the washer body. The screenings washer shall be provided with not less than two (2) separate connections for injecting wash water into the screenings and one (1) connection to the drain pan underneath the wash and press body. The unit shall be designed to accept wash water from the facility’s non-potable water system, which is sourced from final plant effluent.
2. The main wash water supply line to the wash and press unit shall be provided with two (2) 1” diameter Burkert normally-closed solenoid valves with maximum operating pressure of 140psi. The solenoid valves shall be independently controlled by the PLC in the control panel. One solenoid valve shall supply wash water directed against the rotation of the screw flights in the inlet hopper and into the compaction zone of the WAP. The second solenoid valve shall direct wash water to the drain pan beneath the screenings washer body.

E. DRAIN PAN

1. The drain pan shall collect the spent wash water and filtrate water squeezed from the screenings. The drain pan shall be fabricated from 1/8” thick (3 mm) stainless steel and shall connect to the screenings washer body with stainless steel clasps for easy removal.
2. The drain pan shall include one (1) 3/4" threaded inlet connection for wash water from the manifold to flush the trough for cleaning purposes. A 3-1/2” (89 mm) diameter drain connection shall be provided to discharge the drained water back into the channel on the downstream side of the screen.

F. DISHARGE PIPE

1. The wash and press discharge pipe shall be made of stainless steel and shall be connected to the screenings washer body by a 10” (250 mm) diameter flange. The diameter of the straight section of the discharge pipe shall increase in size to ease the transport of the screenings. The diameter of the discharge pipe straight section shall

increase from 10-1/2” to 13-3/4” (267 mm to 350 mm). The bend fittings on the unit’s discharge pipe shall have a radius that is three times (3x) larger than the pipe diameter.

G. GEAR MOTOR DRIVE MECHANISM

1. The drive unit shall be a gear motor rated for continuous duty and shall be selected to match the requirements of the particular wash press. The drive motor shall be totally enclosed designed for application in a C1D1, C1D2 or non-classified area. The motor shall be a constant speed unit rotating at 1760 rpm, and shall be powered by 230/460 VAC, 60 Hz, 3 phase power.
2. The drive unit shall be direct coupled to the screening wash and press drive shaft through the gear box. The gear box housing shall be constructed from ASTM A-48, Class 30 cast iron.
3. The gear box shall be designed for AGMA Class II, 24 hour duty.

2.04 CONTROLS AND INSTRUMENTATION

A. All controls necessary for the fully automatic operation of the Wash and Press (WAP) shall be provided. The controls either need to be tied into the screen controls by dry contacts or components can be incorporated within the screen control panel.

B. Controls and electrical shall comply with requirements of specification division 26 and specification division 40

C. A single main control panel shall be furnished with a lockable NEMA 4/12 painted steel enclosure together with a single local push button station rated for a NEMA 7, Class 1 Division 1 environment. Control panels shall be made by a U.L. listed company and shall bear a U.L. label.

D. The individual WAP control panel enclosure shall incorporate the following:

1. Reversing motor starter, type IEC with Circuit Breaker Branch Circuit Protection
2. Disconnect, circuit breaker, pad lockable
3. Current monitoring relay
4. Panel heater with thermostat, if required
5. Indicator lights for:
    a. Power on (white)
    b. WAP drive running (green)
    c. WAP fault (red)
6. Control power transformer, single phase, 480 – 120 V AC with branch circuit fuses
7. Transient voltage surge suppressor TVSS, 120 V AC single phase
8. Programmable controller: Modicon M340 or approved equal

E. Operator interface: Modicon Magellis or approved equal

F. LOCAL CONTROLS FOR EACH WAP

Local operator station shall be provided and shall be suitable for wall-mounting. The local controls shall be incorporated into a single enclosure. The enclosure shall be NEMA 7, cast aluminum. Door mounted equipment includes the following:

1. System Reset push button (black)
2. E-stop push button (red)
3. Selector switches:
    a. WAP drive: forward – OFF – reverse
    b. WAP drive: Hand – OFF – Automatic
    c. Hopper and Press Zone Wash: Hand – OFF – Automatic
    d. Pan Wash: Hand – OFF – Automatic

E. SEQUENCE OF OPERATION

1. Sequence of operation for Wash and Press (WAP) is operated based on the run time of the associated screen. The control panel of the WAP shall receive a signal from screen panel when in operation and accumulate the time the screen is in operation. The WAP starts wash cycle when the accumulated screen operation time reaches the set point.
2. Wash Cycle:
    a. Wash water supply is activated: ON/OFF mode with adjustable timers for each operational condition
    b. Drive runs forward also controlled by timers with adjustable ON / OFF sequence
    c. Wash cycle is followed by discharge cycle: screw is running forward for an adjustable time
    d. Pan wash is activated
    e. Wash cycle finished
3. High screening load condition: screen is discharging very high amount of screenings the WAP is switching into discharge mode; this condition is determined by the accumulated run time of the screen.
4. WAP shall have the ability to clear blocking automatically: if current monitoring relay senses high load condition the screw stops and a clearing cycle is initiated: the screw stops immediately and reverses (time is adjustable at operator interface) and starts running forward. The number of attempts to clear the blocking is also adjustable – if screw is not cleared after allowed number of attempts or the overload is sensed during reversing the system stops immediately and an alarm signal is rendered.

PART 3: SPARE PARTS

The following Spare Parts shall be included and supplied together with the equipment:

a. Six (6) Guide bars

b. One (1) Cleaning brush

c. One (1) Solenoid valve rebuild kit

PART 4: EXECUTION

4.01 INSTALLATION, START-UP AND OPERATOR TRAINING

A. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify engineer of significant deviations.

B. Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply anchor bolts for the equipment. Contractors shall install the anchor bolts in accordance with the manufacturer's recommendations.

C. After installation, touch-up paint shall be applied to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting. Contractor shall passivate all field welds.

D. Supplier shall furnish the services of a factory-trained service technician for one (1) trip including a total two (2) workdays to inspect the installation, observe start up, and provide operator training.

1. Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the service technician present.

2. The service technician shall make all necessary adjustments and settings to the controls.

3. The service technician shall demonstrate proper and sequential operation of the dewatering system. The dewatering system shall be able to operate fully automatically.

4.02 WARRANTY

A. The manufacturer will warrant against any defects in material or workmanship to the screw press and framework. This warranty will commence upon delivery of the products and will expire on the earlier to occur of one (1) year from initial operation of the product or 18 months from delivery thereof (the "Warranty Period").

END OF SECTION 462173

SECTION 462323 - VORTEX GRIT REMOVAL SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, equipment, materials and incidentals required to completely install and place into operation the one (1) vortex grit chamber(s).

B. The unit(s) shall be furnished and installed with all necessary accessory equipment and auxiliaries, whether specifically mentioned in these specifications or not, and as required for an installation incorporating the highest standards for the type of service specified, including field technician representation during start up of the unit(s), and instruction of the Owner's personnel in the care, operation and maintenance of all equipment.

1.02 RELATED SECTIONS

A. Concrete work is included in Division 3.

B. Metal work is included in Division 5.

C. Field painting is included in Division 9.

D. Instrumentation is included in Division 13.

E. Electrical work, except as specified herein, is included in Division 16.

1.03 SUBMITTALS

A. Provide shop drawings and product data in accordance with Section-013300 for the equipment being furnished, such that the information shall at least include the following:

1. Certified shop drawings showing all details of construction, dimensions and anchor bolt requirements.
2. Descriptive product literature and catalog cuts
3. Complete bill of materials for the equipment.
4. Recommended spare parts list

B. Operation and Maintenance Data

1. Submit operation and maintenance data in accordance with Section 017823.

1.04 REFERENCE STANDARDS

A. American Iron and Steel Institute (AISI).

B. American National Standards Institute (ANSI).

C. American Society for Testing and Materials (ASTM).

D. American Bearing Manufacturers Association (ABMA).

E. American Gear Manufacturers Association (AGMA).

F. National Electrical Manufacturers Association (NEMA).

G. National Fire Protection Association (NFPA).

H. Underwriters Laboratory (UL).

1.05 QUALITY ASSURANCE

A. All equipment covered by these specifications shall be furnished by one manufacturer and shall be complete including motor and appurtenances. The equipment shall be the product of a single manufacturer regularly engaged in the production of equipment for the specified use. The manufacturer shall have the sole responsibility for the proper functioning of the equipment as furnished.

B. The grit removal equipment shall be manufactured by OVIVO (design basis) or equal. Contractor shall be responsible to adjust installation, concrete tank design, gate/channel and inlet design, outlet design, and confirm hydraulics to accommodate alternate equipment

C. Manufacturers regularly engaged in the manufacture of the grit removal equipment herein and who can demonstrate equipment of this specified design, in actual service for a period of not less than 25 years will be considered as acceptable manufacturers.

1.06 WARRANTY

A. The equipment shall be warranted for a period of one year from the date of start up to be free from defects in workmanship, design or material. If the equipment should fail during the warranty period due to a defective part(s), it shall be replaced in the machine and the unit(s) restored to service at no expense to the Owner.

1.07 DESIGN REQUIREMENTS OF THE VORTEX GRIT CHAMBER

A. The grit removal chamber will be a circular tank with a tangential entry. The flow will travel through 360 degrees before exiting the outlet channel on the opposite side of the inlet channel. The grit will be separated from the wastewater in the upper section of the chamber and collected in the lower storage hopper. The floor of the upper section shall be sloped to enable the grit to fall by gravity to the storage hopper. Systems that offer a flat floor that hydraulically scour by the action of a four bladed propeller will not be acceptable.

B. The system will be able to guarantee removing grit as specified below at the hydraulic peak flow rate with no decrease in efficiency at flows less than the design capacity. The manufacturer must be able to offer a proven test procedure that can be applied following installation.

Number of grit chambers	One (1)
Peak flow per chamber	18 MGD
Average flow per chamber	9 MGD
Head loss at peak flow	<1/2 Inch
Operational performance guarantee	
Grit greater than 200 mesh (74 Microns)	95%

C. There shall not be any moving parts subject to wear or stoppage below the water surface. It shall not be acceptable to include mechanical fluidizer vanes or any other moving part in the storage hopper.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment shall be supplied by a single manufacturer in order to provide standardization for appearance, operation, maintenance, spare parts and manufacturer's service.

B. Subject to compliance with the requirements of the specification the acceptable manufactures and products are:

1. OVIVO.
2. Smith and Loveless.
3. Or Approved Equal.

C. Nameplates with the name of the manufacturer, equipment model number and all other pertinent data shall be affixed to each unit at a visible and accessible location.

D. All anchor bolts shall be furnished by the manufacturer and be installed in accordance with the manufacturer's instructions and recommendations.

2.02 GRIT REMOVAL SYSTEM

A. GENERAL

1. The grit removal system will operate on the vortex principle and the concrete chamber will be constructed in accordance with the contract drawings. The equipment manufacturer will supply a geared drive assembly that will be centrally mounted by the contractor on the support bridge and be robust enough to fully support the dive tube and impeller that will be in continuous operation.
2. The internal rotating mechanism will be a flat plate impeller that is specifically designed to separate sewage solids so that the heavy grit falls by gravity into the storage hopper

and the light organic solids and rags are rejected out of the upper chamber into the outlet channel.

3. An Annulus Ring will be provided to increase the grit retention time in the lower grit chamber. The Annulus Ring will be of stainless steel construction and will be supplied by the Grit System manufacturer. The assembly will be mounted to the wall of the grit chamber using stainless steel epoxy anchors at an elevation to be determined by the Grit System manufacturer.
4. The 4-inch diameter grit suction pipe will be an integral part of the grit removal system running from the storage hopper up through the drive tube and drive head to terminate in the top mounted grit pump.
5. The 1.5 inch diameter grit fluidizing pipe will run parallel with the suction pipe from the storage hopper to terminate with a solenoid valve above the drive head. The Contractor will connect this point to the water supply.
6. The equipment manufacturer will have at least 1,000 completed installations and 25 years of experience manufacturing vortex grit systems.

B. MECHANICAL GEARED DRIVE ASSEMBLY

1. The gear head shall comprise of a heavy duty gray iron base and cover securely bolted together to form a composite unit. The base section shall support a 21 inch turntable bearing, designed to protect against any distortion, and that has a minimum B-10 life of 20 years.
2. The drive tube is rotated at no more than 13 rpm by a heavy duty iron spur tooth bull gear wheel securely bolted to the turntable bearing. This bull gear is driven by a steel drive pinion mounted on the output shaft of the helical gear motor. An alloy cover designed to support the helical gear motor will have an access located to ensure that the gear wheel and pinion are correctly centered. The pinion and the bull gear will have a service factor of 5.0 or greater at standard operating speeds.
3. The bull gear will have an opening for the 10.75 inch drive torque tube that rotates the impeller. The gearbox shall be sealed and the bottom opening will include an air bell around the drive torque tube to prevent the ingress of water into the gearbox.
4. The whole geared drive assembly shall be suitable for daily 24 hour service.

C. IMPELLER

1. The impeller is located between the upper section of the chamber and the lower storage hopper. There shall be a 2 inch gap between the outer edge of the impeller and the tank wall to allow the free passage of the grit particles.
2. The impeller is only supported and driven by the drive torque tube and no other attachment points will be permitted.
3. The impeller will be a single flat disc plate with four equally spaced vanes fixed to the top side. These vanes will be inclined back against the flow to create the radial forces necessary to ensure that grit particles fall by gravity to the storage hopper and a gentle upward current to eject light solids from the tank. Systems with axial flow propellers

rotating faster than 13 rpm and a separate cover plate over the storage hopper will not be acceptable.

4. The impeller will have a 4 inch opening behind each inclined vane which will allow light solids to re-enter the upper chamber following washing in the storage hopper.
5. The impeller shall be supplied in two sections and shall be clamped to the drive tube. The performance of the impeller is adjustable by re-setting the vertical position of the impeller on the drive tube.
6. The impeller and the drive tube shall be fabricated from 304L Stainless Steel.

D. SUCTION PIPE

1. The 4 inch diameter suction pipe will run from the storage hopper into top mounted grit pump mounted on the bridge. The suction end must be at least 4 inches from the chamber floor to prevent the chance of blockage.
2. The suction pipe will be straight and will lift through the drive tube and the drive head and directly into the pump. It shall not be supported off the chamber wall.
3. The 1.5 inch diameter grit fluidizing pipe will run parallel to the suction pipe and terminate above the drive head. It will deliver air or water supply to agitate the grit prior to the pumping cycle.

E. GRIT FLUIDIZING

1. The CONTRACTOR shall supply and install a 1.5 inch diameter pipe that runs parallel with the 4 inch suction pipe and terminates in the storage hopper of the vortex grit chamber as shown on the contract drawings.
2. The CONTRACTOR will connect the pipe to a water supply that can provide a 35-45gpm @ 60 psig at the suction point. This will fluidize and agitate the settled grit for a period of two (2) minutes before each pumping cycle.
3. The MANUFACTURER shall supply a 1.5 inch solenoid valve and two (2) manual isolation valves for installation by the CONTRACTOR as shown on the contract drawings.
4. The MANUFACTURER will control the solenoid valve and therefore the fluidizing cycle through the grit pump control panel described in 2.04.

2.03 GRIT PUMP

A. OPERATION CRITERIA

	Flow GPM	TDH FT	Max. Pump RPM	Solids Passage	Min. Suction Dia.	Min. Disch. Dia.	Motor HP	Motor RPM
Design Condition	250 GPM	30’	750	3”	5”	4”	15HP	1800
Secondary Condition								

B. DESIGN & PERFORMANCE

1. The pumps shall be capable of continuous operation.

2. With the pumps designed for use in pumping abrasive grit and other solids, the pumps shall be specifically designed to minimize both contact between abrasive grit particles and the impeller, and recirculation of the grit within the pump volute, for optimizing the wear resistance of the pump, and to allow passage of large solids without clogging.

3. The pump(s) shall include a fully recessed, vortex type impeller design, with the impeller mounted completely out of the flow path between the pump suction and discharge connections, with the pump process fluid never required to flow through the impeller.

4. The impeller shall include a rim around the outer periphery of the impeller vanes, to eliminate wear on the portion of the volute that surrounds the pump impeller, and on the outer tips of the impeller vanes.

5. The pump impeller and volute shall be constructed of a durable, wear resistant material for high resistance against any abrasive particles that are able come in contact with the inside of the pump.

6. The pump volute shall include an independently removable suction piece, allowing easy access to the inside of the pump for inspection without the need to disassemble any other pump component, and for easy replacement of the pump impeller.

7. The pump impellers shall include a radial vane design, such that the impeller is best capable of producing a vortex and providing optimal performance of the pump.

8. Pump Power Frame: To include grease lubricated, reverse-taper roller bearings, to increase the effective load span and improve power frame life. Tapered rollers include a pumping action that discharges grease to the outside, preventing ingress of slurry and eliminating possibility of failure due to over-greasing. The heavy-duty shaft and tapered roller bearings are to be rated at 100,000 hours minimum of B10 life.

C. MATERIALS OF CONSTRUCTION

1. The pump parts exposed to abrasive wear - case, removable suction piece, and impeller, shall be of Hi-Chrome Iron material, with a minimum of 650 Brinell hardness, for maximum durability of the pump.

2. Power frame to include a heavy duty cast iron pedestal.

D. SHAFT SEALING

1. Mechanical Seal

E. MOUNTING

1. Side by Side Belt Drive

a. The pump manufacturer shall provide a common pump and motor base, constructed from structural steel for suitable reinforcement and support of the full weight of the pump, motor, belt drive and guards.

b. The pump manufacturer shall furnish and install a separate, adjustable motor base. The motor base shall be provided with a threaded screw for adjustment so that the motor can be easily moved for V-belt tensioning and adjustment.

c. The pump manufacturer shall supply and install belts and sheaves to drive the pump at the speed necessary to meet the rated conditions.

d. A belt guard shall be provided to safely enclose the belt drive.

2.03 MOTORS

A. General

1. Motors shall be as specified herein and shall also conform to specification Section 260000.
2. The motors shall not be overloaded under any normal operating conditions.

B. DRIVE MOTOR

1. The drive motor shall be an integral part of the geared motor that is directly shaft mounted to the gear wheel within the gear head. .
2. Each motor shall be a 0.5 HP designed for a 460Volt, 3 phase, 60 Hz suitable for non-explosion proof environments.

2.04 CONTROLS

A. Controls: The following controls shall be supplied with the grit removal equipment.

1. Provide a totally enclosed, front access type, 460 volt control panel with a NEMA 4 enclosure in accordance with Specification 409513
2. All controls shall be manufactured by a UL508 certified company, and serialized.
3. The control panel wiring shall be neatly cabled and supported in non-flammable wiring raceways.
4. All control devices and switches required for good quality operation shall be supplied in the control panel.
5. Controls shall meet the requirements of specification division 26 and specification 40 as applicable

B. Operation

1. The grit removal system will run continuously 24 hours per day.

2.05 SPARE PARTS AND SPECIAL TOOLS

1. There are no recommended spare parts or special tools.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with the approved shop drawings and the manufacturer's installation instructions.

B. Final electrical connections are to be made by the electrical contractor.

3.02 FIELD QUALITY CONTROL

A. A manufacturer provided service person shall be on site for one (1) trip(s) each lasting a minimum of two (2) day(s) to perform the following services.

1. Equipment Installation
   a. Inspect the completed installation and note any deficiencies.
   b. Complete and provide the OWNER with a copy of an installation report.
2. Equipment Start-up
   a. Assist in placing the system of equipment into proper operation making any necessary recommendations and adjustments.
   b. Provide OWNER with copy of start-up report.
3. Equipment Training
   a. Instruct plant personnel in the operation and maintenance of the equipment system specified herein.
   b. Training sessions shall include, but not be limited to, a classroom session and a hands-on session.

END OF SECTION 462323

SECTION 462413 - SLUDGE MACERATORS

PART 1 – GENERAL

1.1 DESCRIPTION

A. SCOPE: This section specifies top opening inline macerators for the maceration of solids in municipal wastewater sludge, complete with controls and appurtenances.

B. TYPE: The macerator shall be of the motor driven single shaft type with all cutting elements mounted on the drive unit shaft. The macerator design shall be of the type that provides access to all cutting elements by a single, hinged cover. Macerators using dual shaft cutting elements or cutting elements mounted on separate frames will not be considered.

C. EQUIPMENT LIST: Equipment specified under this section includes the following:

Item	Equipment No.
Raw Sludge Pump Station Grinder	ME-62102

D. OPERATING CONDITIONS: Equipment furnished under this section will be installed and will be used to reduce the size of solids contained in primary sludge. Ambient conditions are expected to range between 60 and 80 degrees F. The fluid to be processed by the macerator is expected to contain up to 6% wastewater solids containing organic and inorganic particles, petroleum products, grease, rubber goods, vegetable parts and pits, wood fragments, plastics, and metallic objects. The macerator will be located on the suction side of a pump and will be supplied with 230/480/575 volt, 60 cycle, AC power.

E. PERFORMANCE REQUIREMENTS: Equipment furnished under this section shall be capable of processing not less than 80 gpm of 6% sludge and reducing all particles passing through the macerator to a size not to exceed 0.75 inches in any dimension. Equipment furnished under this specification shall operate without vibration exceeding that specified in ANSI/HI 9.6, figure 9.6.4.4.

F. DESIGN REQUIREMENTS

1. GENERAL:

a. The macerator shall be designed to be installed as shown in a process pipeline to continuously macerate primary sludge from a wastewater treatment plant. Solids to be encountered during operation of the macerators are those typically found in municipal wastewater sludge and include heterogeneous mixtures of organic and inorganic material. Concentrations of solids are expected to range up to 6% percent. Organic solids include fecal material, vegetable parts and pits, rubber goods, plastics, paper products, balls of rags and hair, bones, small chunks of wood, and semi-solid grease particles. Inorganic solids will include rocks, sand, and metal pieces of various sizes and composition. The liquid is expected to contain oil, grease, petroleum products, solvents, and water.

b. The equipment shall be capable of operation with liquid in the pipeline, and shall operate without an external source of water for flushing seals or cutter faces. The design shall also permit removal and replacement of internal rotating parts without removing the macerator side housings from the piping system. The macerator shall be supplied with 6" ANSI B16.1 125-pound flanges.

c. The macerator shall be provided with a dedicated controller to control operation of the machine. The controller shall have sensors designed to detect motor overload and initiate momentary reversal of cutter operation to cure the condition, and then resume normal operation. If the overload clears, normal operation shall be maintained. If the overload reoccurs, the process shall be repeated. If overload still remains after three attempts within 30 seconds, the controller shall lock out the macerator's control circuits and initiate alarm through dry contacts to an external circuit.

2. CHARACTERISTICS: Equipment furnished under this section shall conform to the following:

Macerator

Pipe size, inches	6"
Rated capacity, gpm	300-600 @ 3% solids
Maximum pressure loss at rated flow, feet	1.5
Particle passing size, max., inches	0.75

Motor

Horsepower, maximum	3
RPM	210
Type	TEFC

Controls

Enclosure	NEMA 4X

3. FACTORY TESTS:

a. The macerator shall be hydrostatically tested at the factory. Test pressure shall be 30 psig, which shall be held for a period of not less than 60 minutes. Leakage throughout the test period shall be zero.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufactures:

1. Vogelsang, Rota-Cut Model

2. Or Approved Equal

2.2 MATERIALS

Component	Material
Casing, including cleanout cover	Steel, SAE 1015 hot dipped galvanized
Shafts	Steel, AISI 4140, tensile strength 150,000 psi minimum
Blades	Cast steel, AISI 4130, through hardened to 48-50 Rockwell C or Steel, X50CrMoW9-1-1, hardened to 45 Rockwell C
Cutter Screen	Hardox 550, through hardened to 550 brinell hardness
Seals	Buna-N
Fasteners, including bolts nuts, washers and keys	Stainless steel

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion.

2.3 EQUIPMENT

A. BODY:

1. The macerator body shall consist of a drum with flanged piping connections, flanged cleanout (6-inch minimum) and hinged top cover plate. The cover plate shall be reinforced to bear the weight to the drive and cutter assembly and shall be held in place by one or more quick-opening latches. The top opening shall be sealed with an O-ring seal to sustain an internal pressure of not more than 30 psig. Piping connections shall be 125 psi ANSI B16.1 and shall be located at 180 degrees (in plan) from each other and shall be concentric with each other. The flanges shall be located in the upper half of the drum to permit storage for periodic removal of heavier objects in the flow processed by the machine. A mounting frame shall be provided to permit anchor bolting the macerator to the housekeeping pad indicated. Installation details shall conform to the requirements.

B. The top cover hinge mechanism shall be reinforced and of sufficient strength to, when the cover has been opened, to hold the drive unit, cover plate and cutter assembly firmly in a position which places the cutter shaft in essentially a horizontal position with the cutter assembly exposed for maintenance. The hinge assembly shall also provide sufficient strength to allow removal and reassembly of the drive and cutter assembly. The top cover hinge hatch shall be locked into place with a simple hand latch for easy access. A hydraulic mechanism shall provide both assist and shock dampening action during the opening/closing process. A NEMA safety switch shall be provided with contacts set to open when the cover latch is not in the engaged position. Internally, the macerator shall be configured to induce a rotational effect in the flow processed by the machine to encourage centrifugal separation of heavy objects such as stones and metal items.

C. CUTTING ASSEMBLY:

1. The cutting assembly shall consist of a matched cutter (consisting of a star shaped multiple arm mounting of a minimum of 4 cutting blades) and hardened cutter screen selected to provide the specified particle passing size. The cutter shall mount the blades to effect efficient cutting in both the forward and reverse direction. Screens shall be designed to be reversed by maintenance personnel to provide extended life before they

must be replaced. Screens that do not support the blades, have continuous bars, or wear on both sides of the screen shall not be accepted.

D. AUTOMATIC CUTTING CONTROL

1. The cutter shall rotate on the drive shaft and be held in position against the grid / screen by a automatic tensioning device. The automatic tensioning device, Auto Cut Control (ACC) shall automatically adjust the tension of the cutting blades without manual user intervention. Using high pressure air over the top of an oil chamber to keep the blades tensioned at all times. The ACC controls shall have one air canister and one oil canister with a pressure regulator between them. Each canister shall have their own pressure gauge to verify pressure, and pressure valve to add pressure via a simple hand pump. The ACC shall use a hydraulic cylinder to adjust the blades for optimum cutting performance. When the blades have completed their running time the control panel shall indicate the blades need to be replaced, after the ACC loses pressure on the blades. Macerators without automatic tensioning devices shall not be considered.

E. DRIVE UNIT:

1. The drive unit shall consist of an electric motor, operating through a TWO-STAGE planetary gear to achieve an operating speed of 177 rpm. The concentric shaft, planetary gear shall be designed in accordance with AGMA 6010-E for continuous heavy-duty shock loading and shall be sealed in grease. The drive motor shall be of the type specified and shall be energy efficient, conforming to the requirements of the specifications. The mechanical seal on the gear output shaft shall be a non-metallic design using an O-ring seal in a bath of hydraulic fluid to protect the gear motor from entrance of sludge into the gear motor enclosure.

F. CONTROLS:

1. Controls shall meet the requirements of the following specifications
    a. 409433 – Human Machine Interfaces
    b. 409443 – Programmable Logic Controllers
        i. Modicon M340 is the preferred controller
    c. 409513 – Process Control Panels and Hardware
    d. Division 26 specifications as applicable
    e. Division 40 specifications as applicable
2. The macerator shall be furnished with a full set of operating controls enclosed in a 316 stainless steel type NEMA 4X enclosure for filed mounting as indicated. The controls shall include the following:

a. 480 volt, 3 phase, 60 cycle reversing starter.
b. Automatic reversing every 2 Hours for self-sharpening.
c. Overload protection system, operating on motor amperage, to reverse the macerator motor on preset (adjustable) rise in motor current.
d. Forward and reverse (red) operation indicating lights
e. Power available (amber) indicator
f. Hand (green) operation indicator
g. Cover latch disengaged indicator (white)
h. Hand-Off-Automatic switch

i. Auto tensioning system for cutter position for blade change (red)
j. Interlock with cover safety switch to prevent unit operation when the cover is unlatched.

2.4 SPARE PARTS

A. The following spare parts shall be provided for each macerator size:
4 sets – gaskets
2 complete sets. all cutting surfaces

B. Spare parts shall be packed and boxed.

PART 3 EXECUTION

3.1 INSTALLATION

A. The equipment specified under this section shall be installed in accordance with the manufacturer's recommendations and the details shown.

3.2 TRAINING

A. The Contractor shall cause a factory trained representative to conduct not less than 4 hours of training for plant personnel on operation and maintenance of the equipment provided under this section.

3.3 WARRANTY

A. Upon completion of all installation, testing and training, the Contractor shall deliver to the Construction Manager a written warranty covering the operation of the macerator for not less than 2 years from the date of use of the equipment. The warranty shall be on the manufacturer's letterhead and shall obligate the manufacturer and no other party. The warranty shall be for materials & defects on the macerator.

B. The manufacturer of the in-line macerator shall have a standard two year, 100% parts and labor warranty, including wear and tear to the macerator. This warranty shall include, but not be limited too mechanical seals, cutting screens, and blades. Non- manufacturer warranty will be unacceptable. All warranties must be in writing, at the time of the bid.

C. The MANUFACTURER'S warranty period shall run concurrently with the CONTRACTOR'S warranty period. No exception to this provision shall be allowed.

3.4 EXPERIENCE

A. Qualified manufacturers shall have a minimum of 10 like installations with a minimum of 2 installations within the state. Manufacturers not meeting this requirement will not be considered.

END OF SECTION 462413

SECTION 463333 – POLYMER BLENDING AND FEED EQUIPMENT

PART 1 – GENERAL

1.01 SUMMARY

A. Furnish polymer blending unit (PBU) with progressive cavity pump, motors and controls, including all integral piping, valves, fitting, pipe supports, special equipment and appurtenances in accordance with these specifications, including all incidental work necessary to make it complete, satisfactory and ready for operation.

B. The polymer dilution and feed system shall be capable of effectively activating and fully blending with water a homogenous polymer solution ranging from 0.1% to 1% concentration of emulsion polymers with active contents up to 75%.

1.02 SYSTEM DESCRIPTION

A. DESIGN CRITERIA

1. Polymer Type: Emulsion
2. Polymer Activity (percent active): 30 to 75
3. Solution Concentration Range: 0.1% to 2% based on neat polymer
4. Solution Concentration Design Point: 0.35% based on neat polymer

Neat Polymer Flow Rate (GPH)	Dilution Water Range (gpm)
2.6	2-20

1.03 SUBMITTALS

A. Product Data:

1. Submit data completely describing product, including detailed scope of supply, detailed bill of materials and annotated specification sheets of all components.

B. Shop Drawings:

1. Submit detailed specifications and shop drawings with both shaded isometric and orthogonal views of the proposed system, including dimensions and weights.

2. Submit wiring, control schematics, and control logic diagrams for all electrical and control components furnished.

C. Provide detailed Operations and Maintenance Manuals including storage, installation start-up and operating instructions. Provide safety precautions and warnings of all hazards operating equipment.

1.04 QUALITY ASSURANCE

A. Prior to shipment the system shall be inspected for quality of construction verifying all fasteners and fittings are tight, all wires are secure and connections whisker-free.

B. The complete system shall be fully factory tested prior to shipment. Testing shall include: Setting and verification of all instrumentation and sensors per the design requirements of the application; pressure testing all plumbing systems for a minimum of one hour at 100 psi. If leaks are found they shall be fixed and a new test shall be conducted for one hour at 100 psi until the plumbing system is verified to be leak free; verification of system design flow rates, and; complete functional simulation of operation.

C. Polymer mixing and injection system must be suitable for and compatible with the associated sludge dewatering equipment, including providing the full range of minimum and maximum required polymer dosing to meet the full intended operating range of the sludge thickening equipment package.

1.05 WARRANTY

A. The system shall be covered by a one (1) year limited warranty against defects in materials and workmanship. The mixing chamber shall be warranted for the life of the system against failure for plugging for any reason. The warranty shall exclude failure due to over pressure or freezing.

1.06 SPARE PARTS & SPECIAL TOOLS

A. One (1) progressive cavity pump stator
B. One (1) progressive cavity pump shaft seal
C. One (1) banding clamp tool for replacement of the progressive cavity metering pump pin joint banding clamps.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. VeloDyne
B. Or equal

2.02 IDENTIFICATION

A. Provide a name plate securely affixed to the unit providing Manufacturer with phone number, model number, and serial number.

2.03 MATERIALS

A. System skid: 304 stainless steel
B. Hardware: Type 18-8 stainless steel
C. Inlet and Outlet fittings: 304 stainless steel
D. Piping & pipe fittings: schedule 80 PVC

E. Tubing and tube fittings: polyethylene, polypropylene, stainless steel and Viton
F. Water solenoid valve: Brass
G. Pressure gauges: Stainless steel, liquid filled
H. Pressure switches: NEMA 4, brass connection
I. Flow meter: Acrylic, stainless steel, PVC and or polypropylene
J. Water control valve: Stainless steel with stainless steel seat
K. Mixing chamber body/flanges: Stainless steel
L. Mixing Chamber Discharge: Stainless steel
M. Mixing chamber pressure relief valve: Brass, stainless steel or PVC
N. Metering pump wetted parts: Stainless steel & Viton
O. Metering pump shaft seals: Viton, stainless steel ceramic, carbon

PART 3 – Field Services

3.01 Field Services:

A. Provide the services of a qualified field service technician to inspect and certify the installation, start-up the equipment, troubleshoot any problems that may arise and providing complete and thorough training of operator personnel.

END OF SECTION 463333

SECTION 463350 – MOVING BED BIOFILM REACTOR (MBBR) EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Division 16481: Motor Control Center

B. Division 17000: Instrumentation

C. Division 16000: General Electrical Requirements

D. Division 098000: Protective Coatings

E. Division 220523: Valves

1.2 GENERAL CONTRACTOR SCOPE OF WORK

A. Installation of all equipment and materials as provided by the SYSTEM SUPPLIER.

B. Supply and installation of all sample pumps and sample piping as required for the instrumentation provided by the SYSTEM SUPPLIER.

C. Provide all labor, materials, supplies and utilities as required for startup, adjustment and performance testing including laboratory equipment, laboratory facilities, analytical work and chemicals.

D. Contractor shall provide all chemicals, lubricants and other supplies required for equipment startup and adjustment.

E. Provide all anchor bolts for equipment and piping, including those provided by the SYSTEM SUPPLIER.

F. Assist the SYSTEM SUPPLIER with process startup activities.

G. Supply and installation of all insulation and heat tracing for all tanks and piping subject to freezing temperatures.

H. Provide and install all piping required to connect to the SYSTEM SUPPLIER'S equipment.

I. Provide all support beams and/or slabs, platforms, grating, floor plate, handrails, hatches, ladders, and platforms as required.

J. The CONTRACTOR shall install and test all level floats, level transmitters, level alarms, and alarm communication devices prior to filling a process tank with media and water.

K. Installation of all control panels and instrumentation provided by the SYSTEM

SUPPLIER in compliance with Division 16.

L. Supply and install all electrical power, control wiring and conduit to the Biological Treatment System equipment, including wire, telephone lines, cable trays, cable, junction boxes, fittings, disconnects, conduit, etc. in compliance with Division 16.

M. The CONTRACTOR shall coordinate the installation and timing of all interface points such as piping and electrical tie-ins with the SYSTEM SUPPLIER.

N. Supply and installation of any embedded pipe sections or wall inserts, if applicable, for any penetrations including but not limited to those for drop pipes and instruments.

O. Supply of all manual valves on aeration system drop pipes upstream of the MBBR SYSTEM SUPPLIER / CONTRACTOR interface, unless explicitly provided by the MBBR SYSTEM SUPPLIER.

P. Coordination and timing of all interface points such as piping and electrical tie-ins with the MBBR SYSTEM SUPPLIER.

Q. Video recording of any training activities.

R. Supply and construction of MBBR reactors whose interior surfaces are free of all form marks, with all voids filled.

S. Concrete Tank Finish adhere to requirements of ACI 301 (2011) for form facing materials and as-cast finishes.

1.3 SYSTEM SUPPLIER SCOPE OF WORK

A. The SYSTEM SUPPLIER shall furnish the process design, equipment, and process performance guarantee for a Biological Treatment System, as shown on the Contract Drawings and specified herein. In addition to the equipment shown below, technology licenses and patent infringement indemnification shall be included in the SYSTEM SUPPLIER's scope. A single SYSTEM SUPPLIER shall supply the process equipment for Biological Treatment System in order to establish system performance responsibility.

B. Mechanical process equipment to be furnished under this section includes the following:

1. Plastic media

2. Cylindrical Screen assemblies with air sparge

3. Flat Screen assemblies

4. Coarse bubble aeration grids

5. Modulating airflow control valves

C. Supplier shall list any exceptions to this specification and a written justification of all deviations of this specification.

1.4 QUALIFICATIONS

A. The SYSTEM SUPPLIER of the Biological Treatment System shall be:

1. SUEZ Water Technologies

2. World Water Works

3. Or approved equal.

1.5 SUBMITTALS

A. Submittals shall include the following:

1. Equipment drawings showing all important details of construction and dimensions.

2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Data on the characteristics, features, and performance of the equipment.

4. The total weight of the equipment including the weight of the single largest item

5. Motor drive data.

6. Supplier to provide a comprehensive submittal that includes control narrative and P&ID.

B. The SYSTEM SUPPLIER shall furnish operation and maintenance manuals. The manuals shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, descriptions, and other information that is required to instruct operation and maintenance personnel unfamiliar with such equipment.

C. The CONTRACTOR shall furnish shop drawings, catalog data, operation and maintenance manuals, installation instructions, parts list, layout drawings, equipment design data, testing data and reports to show full compliance with these specifications.

1.6 QUALITY ASSURANCE

A. The installations shall conform to all applicable codes that are typical and reasonable for the type of installation.

B. Requirements of the following organizations shall be considered minimum:

1. OSHA - Occupational Safety and Health Act

2. ANSI - American National Standards Institute

3. ASTM - American Society for Testing and Materials
4. AISI - American Iron and Steel Institute
5. AIWC - American Institute of Steel Construction
6. AWS - American Welding Society
7. AGMA -American Gear Manufacturers Association
8. NEMA- National Electrical Manufacturers Association
9. NEC -National Electric Code.

1.7 PATENTS

A. The SYSTEM SUPPLIER shall assume all costs of patent fees or licenses for equipment or processes it supplies under this agreement, and shall safeguard and save harmless the GENERAL CONTRACTOR, OWNER and ENGINEER and their agents from damages, judgments, claims and expenses arising from license fees or claimed infringements or any letters of patent or patent right, or because of royalty or fee for the use of any equipment or process; and the price stipulated for all such patent fees, licenses, or other costs pertaining thereto.

1.8 DESCRIPTION OF OVERALL SYSTEM

A. The Biological Treatment System shall allow the media to move about freely within a reactor using the supplier's standard aeration system for aerobic reactors. Screen assemblies shall be used to retain the carrier elements within the MBBR system. Wastewater (Influent) is fed to MBBR on a continuous basis.

B. The Biological Treatment System shall be designed for operation in a reactor as indicated on the drawings. Equipment shall be designed for the following:

Parameter	Units	Value
Number of Process Trains	**-**	**2**
Number Reactors Per Train	**-**	**1**
Reactor Dimensions	**ft**	**56' x 56' x 20' SWD**
Reactor Volume	**ft3**	**62,720**
Minimum Freeboard	**ft**	**2'**
Max Reactor Media Fill Carrier Elements	**%**	**25 (regular operation) 50 (maintenance condition)**
Min total protected surface Area	**ft2**	**444**
Aeration System Type	**-**	**Coarse Bubble**
Residual D.O., Design	**mg/L**	**2-4***

C. The SYSTEM SUPPLIER shall provide the following design parameters:

Parameter	Units	Value
Specific Media Protected Surface Area	**ft2/ft3**	**955***
Max Bulk Volume of Media	**ft3 (ea)**	**888 (maintenance condition)***
Min Bulk Volume of Media	**ft3 (ea)**	**444 (regular operation)***
Air Requirements, Design(max)	**SCFM/PSI**	**4,000 (per train)**
Air Requirements, Design (min)	**SCFM/PSI**	**2,100 (per train)**

1.9 PROCESS GUARANTEE

A. Basis of Design:

1. OWNER/CONTRACTOR hereby agrees to the Basis of Design as defined herein, confirms its accuracy and completeness, and agrees that it shall serve as the basis for the Process Performance Guarantee.

2. Basis of Design:

BIOLOGICAL TREATMENT SYSTEM DESIGN FLOW CONDITIONS	
Design Flow, MGD	**9.0**
Peak Hour Flow, MGD	**18.0**
BIOLOGICAL TREATMENT SYSTEM DESIGN POLLUTANT LOAD CONDITIONS	
BOD_5	
Design, mg/L (lb/day)	**14.6 (1,100)**
TSS	
Design, mg/L (lb/day)	**32 (2,400)**
NH_3-N	
Design, mg/L (lb/day)	**17.3 (1,300)**
Site Elevation	
Feet	**4,220**
Wastewater Temperature	
Minimum, C	**12**
Minimum Month, C	**12**
Maximum Month, C	**30**

* See table below for temperature history in degrees Celsius

	2017			2018			2019			2020		
MONTH	Min	Avg.	Max	Min	Avg.	Max	Min	Avg	Max	Min	Avg	Max
Jan	14	16	18	16	18	19	15	17	18	15	17	19
Feb	14	16	19	16	17	19	15	16	18	15	17	18
March	15	17	20	16	17	19	14	16	17	17	19	21
April	17	19	21	17	19	21	16	18	19	18	20	21
May	19	21	25	19	21	22	17	20	21	14	21	26
June	19	24	26	22	23	24	21	22	24			
July	25	26	27	24	26	27	24	26	36			
Aug	26	27	27	26	26	27	24	25	29			
Sept	20	25	28	20	25	27	16	21	24			
Oct	18	22	24	22	24	25	9	13	18			
Nov	16	19	22	19	21	23	10	13	22			
Dec	14	17	20	16	19	20	5	11	19			
Average	14	21	28	19	21	23	15	18	22	16	19	21

3. In addition to the data provided in the Basis of Design, the following conditions shall apply:

- The wastewater shall contain sufficient alkalinity, either present in the wastewater or by means of chemical addition by the OWNER/CONTRACTOR, to maintain a pH in the range of 6.5 - 8.0 in the process tanks.

- The refractory organic nitrogen component is less than or equal to 1.3 mg/L.

- The influent BOD/TP ratio to the activated sludge system shall be equal to or greater than 22.

- With the exception of temperature, all values listed in the Basis of Design are maximum values. The minimum and maximum temperatures in the Basis of Design are based upon a seven (7) day average.

- The wastewater is biodegradable and does not contain any substance or element whose presence or concentration causes interference or inhibition, defined as: a substance that hinders the mechanisms of treatment; or whose treatment byproduct (sludge, dewatered liquor, etc.) is hazardous or otherwise requires additional cost for disposal; or may result in gases or vapors that pose a risk to system performance or human health; or that is corrosive, erosive, or abrasive; or which contains pollutants that obstruct the flow in the system. Examples include solvents, lubricants, preservatives, quaternary ammonium compounds, fugitive polymers, oils, etc.

4. During the Commissioning Period (prior to the Performance Test), should the Influent criteria be out of compliance with the criteria specified in the Basis of Design, the Owner shall make all necessary adjustments upstream of the SYSTEM SUPPLIER's process to bring the Influent into compliance. If this is not possible, the parties shall discuss in good faith and agree on the appropriate change order in order to take into account the impact of such variation with respect to the Basis of Design. The change order shall comprise any necessary adjustments, as appropriate, to the design, the Performance Guarantee, the Performance Test and remedies and modification of the Contract Price and the Contract schedule.

B. Process Guarantee Requirements:

1. The Process Guarantee shall be defined by the table(s) in this section.

2. The Process Guarantee is predicated on all conditions specified herein, in the entirety of the Process Guarantee and Performance Test document.

3. The Process Guarantee shall be conclusively demonstrated through the successful completion of the Performance Test, as described herein.

4. Process Guarantee Table(s). The Biological Treatment System design shall be based on meeting the target effluent limitations summarized in the table below at the DESIGN loading conditions and governing design operating conditions summarized above.

TARGET EFFLUENT QUALITY REQUIREMENTS	
Soluble cBOD5, mg/L	**< 10**
NH4-N, mg/L	**< 3**

5. A Performance Test Protocol shall be prepared by SYSTEM SUPPLIER and approved by ENGINEER prior to commencement of the Commissioning Period.

1.10 PERFORMANCE TEST

A. Timing of Performance Test:

1. Start of the Performance Test

- SYSTEM SUPPLIER shall provide the OWNER/CONTRACTOR written notice with the date when SYSTEM SUPPLIER believes the process has reached system stability (defined below) and is ready for the Performance Test to start in accordance with the requirements described herein.

- SYSTEM SUPPLIER's determination with regard to "System Stability" shall take into account factors that include, but are not necessarily limited to, the following:

    i. The Basis of Design conditions are being met (although at SYSTEM SUPPLIER's discretion, flowrate may be less than the Basis of Design); and

    ii. The System appears to be acclimated to the material (water, wastewater, biosolids, etc.) that it is intended to treat; and

    iii. The System's unit operations are treating the load being provided and appear to be functioning at acceptable operating conditions; and

    iv. The System is being operated with proper pre-treatment, pre-conditioning, or chemical conditioning as instructed by SYSTEM SUPPLIER.

- The Owner/Contractor shall start the Performance Test within sixty (60) days after the date the process has achieved System Stability as determined by SYSTEM SUPPLIER.

2. Duration of the Performance Test

- In the event that the Performance Test is interrupted due to equipment failure, at SYSTEM SUPPLIER's discretion, only the remaining unfinished test period will be tested following modifications/repairs to the System.

- The Performance Test shall consist of one 14-day Performance Test.

3. Performance Test Period Window

- The Performance Test must be conducted within 12 months of delivery of the SYSTEM SUPPLIER's last major equipment item, as provided on the Project Schedule. Should System Stability not be achieved and the Performance Test not be conducted within such time period, then SYSTEM SUPPLIER's total liability with regard to the Process Guarantee shall be discharged and the Certificate of Performance Test Acceptance will be

executed by the Parties.

B. Responsibilities During the Performance Test

1. OWNER/CONTRACTOR

- System Operations

    i. OWNER/CONTRACTOR shall be responsible for providing the Influent conditions as specified in Basis of Design.

    ii. OWNER/CONTRACTOR shall be responsible for furnishing all trained personnel, Influent, materials, utilities, services, chemicals, and all incidentals required for the operation of the complete facility, including SYSTEM SUPPLIER's System.

    iii. Owner/ Contractor shall be responsible for operating SYSTEM SUPPLIER's System in accordance with SYSTEM SUPPLIER's O&M instructions, manuals and instructions, or SYSTEM SUPPLIER's reasonable revisions of the same.

    iv. If required by SYSTEM SUPPLIER, OWNER/CONTRACTOR shall restore the System to the specified operating conditions before testing begins.

    v. Should the OWNER/CONTRACTOR operate the System outside of the specified operating conditions, the Process Guarantee shall be deemed to have been met, and SYSTEM SUPPLIER shall have no further obligation or liability hereunder.

    vi. Should the Owner/Operator already have operated the System outside of the specified operating conditions, and such operation damaged System equipment, the Process Guarantee shall be deemed to have been met, and SYSTEM SUPPLIER shall have no further obligation or liability hereunder.

- Sampling and Analysis

    i. OWNER/CONTRACTOR shall be responsible and bear all costs for collecting all samples, carrying out all laboratory analysis or other tests, and furnishing all necessary labor, laboratory equipment, and supplies.

- Record Keeping and Copies of Records

    i. OWNER/CONTRACTOR shall record and maintain such detailed records as may be necessary for determining whether the Process Guarantee has been met.

    ii. OWNER/CONTRACTOR shall retain such records until the

Process Guarantee has been satisfied, discharged, or until the expiration of the Performance Test Period Window, whichever occurs last.

iii. Owner/Operator's records shall include all daily log sheets, operator notes, sample inspections, calibration reports, laboratory and analytical results, maintenance records, and instrument charts produced in operation of the System.

iv. OWNER/CONTRACTOR shall provide one (1) copy of such records to SYSTEM SUPPLIER at no charge upon SYSTEM SUPPLIER's request.

v. OWNER/CONTRACTOR shall make such records available to SYSTEM SUPPLIER for inspection and for further copying at SYSTEM SUPPLIER's expense.

- Access to the System

i. Owner/Operator shall provide full access to SYSTEM SUPPLIER's System, facility components upstream and downstream of the System that may impact System performance, and test results and records for SYSTEM SUPPLIER's personnel or authorized subcontractor.

2. SYSTEM SUPPLIER

- SYSTEM SUPPLIER shall provide the OWNER/CONTRACTOR O&M instructions and manuals to advise the OWNER/CONTRACTOR, and reasonable revisions of the same, on System operation.

- SYSTEM SUPPLIER shall have the right, but not the obligation, to:

i. Inspect the System prior to testing to ensure the System meets SYSTEM SUPPLIER's specified requirements for operation.

ii. Provide technical personnel on-site to provide technical input and to observe the Performance Test.

iii. Witness sampling and analysis, and to take its own samples to a lab of SYSTEM SUPPLIER's choosing for analysis at SYSTEM SUPPLIER's expense.

iv. Carry out adjustments to the System to optimize or improve the System's performance.

- SYSTEM SUPPLIER shall consolidate the Performance Test data (data provided by OWNER/CONTRACTOR) and provide the OWNER/CONTRACTOR with the results in a Performance Test Report.

C. Determination of Performance Test Result

1. Performance shall be based on the System meeting the Process Guarantee Requirements. Measured values of the System performance shall be based upon

    - 24-hour composite sample result

    - Basis of Design conditions being met

2. Upon receipt of test data confirming that the Process Guarantee has been met, the Performance Test shall have been deemed successful and SYSTEM SUPPLIER's total liability under the Process Guarantee shall be discharged and the OWNER/CONTRACTOR shall have no further recourse against SYSTEM SUPPLIER or any claims for recovery with respect to the Process Guarantee.

3. SYSTEM SUPPLIER shall then execute and submit the Performance Test Report and the Certificate of Performance Test Acceptance.

4. OWNER/CONTRACTOR shall execute the Certificate of Performance Test Acceptance as specified elsewhere herein.

5. If OWNER/CONTRACTOR does not return the executed Certificate of Performance Test Acceptance within fourteen (14) calendar days, the Certificate shall be deemed to have been issued with the effective date being the date the Performance Test was completed.

D. Remedies in Event of Performance Test Failure

1. If, during the Performance Test, all of the Basis of Design conditions are being met, but it appears that the Process Guarantee is not being met due to SYSTEM SUPPLIER'S fault:

    - SYSTEM SUPPLIER shall have the right to have the System operated at such conditions as it may deem necessary or advisable for purposes of determining the nature or cause of the failure of the System to meet such guarantee, provided such operating conditions are in accordance with good engineering practices, OWNER/CONTRACTOR's regulatory obligations, safety rules, operational restraints, and similar requirements.

    - SYSTEM SUPPLIER shall have the right to make or have made such adjustments as it deems necessary or advisable in order to meet such guarantee and to make or have made, at its own expense, such alterations or modifications to the SYSTEM SUPPLIER System as it deems necessary or advisable. It is understood and agreed that any mechanical corrective work necessary to cause the System to meet the Process Guarantee shall be performed by SYSTEM SUPPLIER, a SYSTEM SUPPLIER-authorized subcontractor, or the OWNER/CONTRACTOR as agreed upon by SYSTEM SUPPLIER. Corrective work shall be allowed to commence as soon as practical.

    - SYSTEM SUPPLIER shall have the right to conduct two (2) additional Performance Tests to meet the Process Guarantee at SYSTEM SUPPLIER's expense. Prior to the start of any of these subsequent tests, SYSTEM SUPPLIER shall have the right to make any additional modifications to the

System at SYSTEM SUPPLIER's expense.

- In the event that the System fails to meet the Process Guarantee, SYSTEM SUPPLIER's sole obligation and OWNER/CONTRACTOR's sole remedy shall be to replace or modify the System as SYSTEM SUPPLIER deems appropriate to enable the System to meet such Guarantee, subject to the following:

    i. SYSTEM SUPPLIER shall not be accountable for failure to meet the Process Guarantee during this necessary modification period.

    ii. The OWNER/CONTRACTOR shall allow for sufficient time for the order and delivery of any necessary equipment for SYSTEM SUPPLIER to complete modifications to the System.

    iii. The costs and expenses incurred by the SYSTEM SUPPLIER's shall be subject to the limitation provided in the Contract, which shall in no event exceed the total Purchase Price paid to SYSTEM SUPPLIER for the original System.

2. If the Performance Test fails due to noncompliance with the Basis of Design:

    - If after the commencement of the Performance Test, any daily Influent composite samples taken during such Test are not in accordance with Table 1.09-A, or any other Basis of Design conditions are not being met, the non-compliant Influent shall be treated to the extent possible, while OWNER/CONTRACTOR makes every effort to bring Influent and the System into compliance with the Basis of Design. Notwithstanding such efforts, that day's results and any following days impacted will be excluded from the Performance Test's final results and that day(s) will be considered passed.

    - Upon mutual agreement of the Parties, SYSTEM SUPPLIER may assist OWNER/CONTRACTOR and use commercially reasonable efforts to adjust equipment and controls settings and/or operating guidelines to optimize performance of the facility under the prevailing conditions. All costs and expenses of SYSTEM SUPPLIER as a result of such efforts, including costs related to extension of the Performance Test and the costs of any additional Performance Tests shall be reimbursed by the OWNER/CONTRACTOR to SYSTEM SUPPLIER. Reimbursement shall include at a minimum SYSTEM SUPPLIER's standard labor rates, travel and living costs and expenses. SYSTEM SUPPLIER and OWNER/CONTRACTOR may mutually agree on an extension of the period of time reasonably estimated as necessary to bring Influent and other Basis of Design conditions into compliance and the pertinent, impacted terms of the Contract shall be adjusted accordingly.

    - Should non-compliant Influent have damaged all or part of the Equipment, time shall be allowed to replace or repair the damaged equipment in accordance with the Contract provisions, and associated costs shall be borne by the Purchaser.

3. Should the Parties disagree on whether the Basis of Design (Influent) is compliant, SYSTEM SUPPLIER may take additional Influent [and Effluent] samples and conduct independent laboratory testing and the Performance Test shall be extended and the Contract adjusted accordingly until the results of such laboratory test are available. If the laboratory test results confirm that the Influent is out of compliance, OWNER/CONTRACTOR shall reimburse SYSTEM SUPPLIER for the costs and expenses associated with the sampling and laboratory testing and costs related to the extension of the Contract.

4. Notwithstanding the efforts provided in Section 1.10(F)(2) above, should compliant Influent or other Basis of Design conditions not be attainable within 12 months of delivery of the SYSTEM SUPPLIER's last major equipment item, as provided on the Project Schedule, the requirement to meet the Process Guarantee shall be deemed to have been met, and SYSTEM SUPPLIER shall have no further obligation or liability hereunder. The OWNER/CONTRACTOR shall promptly execute the Certificate of Acceptance, with the last day of the originally scheduled Performance Test being the effective date.

5. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SYSTEM SUPPLIER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SYSTEM SUPPLIER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

6. THERE ARE NO GUARANTEES ESTABLISHED, EXPRESS, IMPLIED OR STATUTORY, EXCEPT THOSE SET FORTH HEREIN.

E. Mechanisms that Discharge the Process Guarantee. Upon any of the following, SYSTEM SUPPLIER's total liability for the Process Guarantee shall be discharged:

1. Successful completion of a Performance Test, as demonstrated by the Performance Test results.

2. OWNER/CONTRACTOR's operation of the System at any time (prior to or during the Performance Test) outside of the operating conditions as specified herein in a manner that does damage to the System's equipment.

3. OWNER/CONTRACTOR's operation of the System during the Performance Test outside of the operating conditions as specified herein.

4. Conditions meeting the Basis of Design are not available 12 months of delivery of the SYSTEM SUPPLIER's last major equipment item, as provided on the Project Schedule, or the OWNER/CONTRACTOR is otherwise unable to complete the Performance Test within such time period.

5. Any other conditions outside of SYSTEM SUPPLIER's control, including but not limited to the following:

- Engineering design (other than that by SYSTEM SUPPLIER).

- Materials and equipment (other than those specified or supplied by SYSTEM SUPPLIER).

- Workmanship and services (other than those provided by SYSTEM SUPPLIER).

- Defective materials or mechanical conditions, or deficient performance of equipment or auxiliary parts (other than those supplied by SYSTEM SUPPLIER).

- Defective conditions or performance of any materials, equipment (other than equipment supplied by SYSTEM SUPPLIER) or work supplied by or contracted for by anyone other than SYSTEM SUPPLIER.

- Failure of the Contractor to furnish adequate utilities, such as, but not limited to, electricity, air, water, etc. as set forth in the O&M Manual and /or O&M training supplied by SYSTEM SUPPLIER, or SYSTEM SUPPLIER's reasonable revisions of the same.

- Failure of the OWNER/CONTRACTOR to provide adequate personnel.

- Mechanical failure of any of the equipment or component parts thereof due to ordinary wear and tear or any other cause.

- Failure of the OWNER/CONTRACTOR to perform any of the responsibilities and obligations specified herein.

- Any other cause outside of a cause attributable to SYSTEM SUPPLIER, including Force Majeure.

- OWNER agrees to waive the Performance Test.

F. Certificate of Performance Test Acceptance

1. Certificate of Performance Test Acceptance shall be executed by both parties upon discharge of the Performance Guarantee:

    - Upon successful completion of the Performance Test, SYSTEM SUPPLIER shall execute and submit the Performance Test Report and Certificate of Performance Test Acceptance to the OWNER/CONTRACTOR. OWNER/CONTRACTOR shall execute the Certificate of Performance Test Acceptance effective as of the date the Performance Test was completed, and return the Certificate to SYSTEM SUPPLIER within fourteen (14) calendar days of its receipt from SYSTEM SUPPLIER. If OWNER/CONTRACTOR fails to execute the Certificate of Performance Test Acceptance within the fourteen (14) calendar days, the Certificate shall be deemed to have been issued with the effective date being the date the Performance Test was completed.

    - Should the conditions provided in Section 1.10(G) prevail, the Certificate

shall be deemed to have been issued with the effective date being the date the Performance Test was originally scheduled to be completed.

- Should the Performance Test and/or Process Guarantee be discharged for any of the other reasons as specified herein, the Certificate shall be deemed to have been issued with the effective date being the date that SYSTEM SUPPLIER determines the Process Guarantee is discharged.

1.11 CERTIFICATE OF PERFORMANCE TEST ACCEPTANCE

CERTIFICATE OF PERFORMANCE TEST ACCEPTANCE

The undersigned representative of the SYSTEM SUPPLIER hereby certifies that the system successfully completed the Performance Test on _____ and as required by the Contract between the SYSTEM SUPPLIER and _____ for the named project.

System: _____

Project Name: _____

SYSTEM SUPPLIER

Signed: _____

Printed or Typed Name: _____

Title: _____

Date: _____

ACCEPTANCE:

OWNER/CONTRACTOR hereby agrees that the system has successfully completed the Performance Test and the Process Guarantee is discharged as of the completion date shown.

OWNER/CONTRACTOR

Signed: _____

Printed or Typed Name: _____

Title: _____

Date: _____

1.12 BOND

A. The SYSTEM SUPPLIER shall provide a process performance bond as an alternative add-on to the base bid to the OWNER. The SYSTEM SUPPLIER shall list the cost for the Bond separately from the equipment purchase price. Bonds will be purchased at the owner's discretion. Bonds shall be valid for a period of one (1) year from beneficial use. The bond shall be for an amount of one hundred (100) percent of the SYSTEM SUPPLIER'S contract value. A letter from the SYTEM SUPPLIER'S surety company shall be provided with the bid at bid time.

1.13 EQUIPMENT WARRANTY

A. SYSTEM SUPPLIER shall warrant to the OWNER that the Equipment shall materially conform to the description in SYSTEM SUPPLIER's Documentation and shall be free from defects in material and workmanship. The warranty shall not apply to any Equipment that is specified or otherwise demanded by OWNER and is not manufactured or selected by SYSTEM SUPPLIER, as to which (i) SYSTEM SUPPLIER hereby assigns to OWNER, to the extent assignable, any warranties made to SYSTEM SUPPLIER and (ii) SYSTEM SUPPLIER shall have no other liability to OWNER under warranty, tort or any other legal theory. If OWNER gives SYSTEM SUPPLIER prompt written notice of breach of this warranty within 18 months from delivery or 1 year from acceptance, whichever occurs first (the "Warranty Period"), SYSTEM SUPPLIER shall, at its sole option and as OWNERS's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If SYSTEM SUPPLIER determines that any claimed breach is not, in fact, covered by this warranty, the OWNER shall pay SYSTEM SUPPLIER its then customary charges for any repair or replacement made by SYSTEM SUPPLIER. SYSTEM SUPPLIER's warranty is conditioned on OWNER's (a) operating and maintaining the Equipment in accordance with SYSTEM SUPPLIER's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to SYSTEM SUPPLIER. SYSTEM SUPPLIER's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by SYSTEM SUPPLIER). THE WARRANTIES SET FORTH IN THIS SECTION ARE SYSTEM SUPPLIER'S SOLE AND EXCLUSIVE WARRANTIES. SYSTEM SUPPLIER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

1.14 SYSTEM CONTROLS

1. Programing and system integration shall be supplied by owner's system integrator.

2. Supplier to provide complete instrumentation and controls strategy for the process system.

PART 2 – PRODUCTS

2.1 GENERAL

A. The work shall generally comprise the supply of a Biological Treatment System complete with process design, media, Aeration System, Screen Assemblies with air sparging, controls and all other related appurtenances required for a complete system.

B. License fees or royalties required in connection with use of the Biological Treatment System shall be included in the Contract Price. The SYSTEM SUPPLIER shall indemnify and hold harmless OWNER against all claims, damages, losses and expenses arising out of any infringement of patent rights or copyrights of the equipment supplied by the MBBR System Supplier.

2.2 MEDIA

A. General:

1. The CONTRACTOR shall install the media into the reactors and maintain an accurate inventory of the number of bags installed in each reactor. These records shall be made available to the ENGINEER or SYSTEM SUPPLIER upon request.

B. Biofilm Carrier Media:

1. The SYSTEM SUPPLIER shall provide a total minimum protected surface area as shown on the contract drawings and in this specification, in the MBBR reactor. Outer surfaces of the biofilm carrier will not be considered protected surface area and should be reflected accordingly in the process calculations.

2. The total media percent fill shall not exceed 55% for design conditions. This allows room for unforeseen increases in load. SYSTEM SUPPLIERS unable to meet this criteria will be required to change the geometries of the MBBR reactors to increase the total working volume. This ensures all manufacturers are using the same safety factor resulting in a fair and equal evaluation.

3. Material shall be an extruded, virgin high-density polyethylene. Recycled materials will not be accepted.

4. The nominal density of the biofilm carrier elements in bulk is 7.37 lb/ft3. The specific gravity of the biomedia shall be 0.95.

5. The SYSTEM SUPPLIERS shall clearly state the following in their bid to CONTRACTOR.

- Protected surface area of carrier element in ft2/ft3.
- Total protected surface area provided for the MBBR system ft2.
- MEDIA percent fill of specified reactor at 20’ SWD
- MEDIA material

2.3 AERATION SYSTEM (MEDIUM BUBBLE)

A. General:

1. The CONTRACTOR shall furnish and install aeration grid(s) in the basin(s) as shown and specified. The Equipment Manufacturer shall furnish the items listed below:

   - Drop Pipe(s)
   - Aeration Grids
   - Supports
   - Air Flow Control Valves (manual and modulating)

B. Equipment:

1. Drop Pipe

   A 304/304L stainless steel drop pipe(s) shall be provided for the aeration grid(s) to a point approximately 3’ above the SWD. The drop pipe shall be schedule 10 pipe and connect to the CONTRACTOR supplied out-of-basin pipe. VENDOR scope ends at the Straub coupling at the top of the drop pipe.

2. Aeration Grids

   A 304/304L stainless steel aeration grid(s) shall be provided for the basin(s) as shown on the contract drawings. The aeration grid(s) shall be comprised of; an aeration grid manifold of schedule 10 pipe with Ø1” or Ø1-1/4”laterals of schedule 5 pipe. The laterals shall be uniformly spaced along the length of the aeration grid manifold. Each lateral will have a series of 4mm (5/32”) holes uniformly spaced along the bottom. The lateral pipe shall include a crimped drop pipe at the end, to provide for easy drainage, and to prevent entry of media. Each aeration grid shall be supplied with all necessary gaskets and hardware.

3. Supports

   Aeration Grid and In-Basin Manifold Supports: Aeration grid and in-basin manifold supports to be fabricated from 304/304L stainless steel. Each support shall consist of a minimum 2” bearing contact between the pipe and support. The support shall be secured by two (2) 18-8 stainless steel threaded rods with a minimum diameter of 5/8”. Each rod will be anchored to the concrete by chemical anchors. The aeration grid and in-basin manifolds shall be secured to the support by a u-bolt to prevent lateral movement. Supports shall be designed to allow for on-site height adjustment. Supports shall have a maximum spacing of 9’-0”. All interconnecting hardware required to secure the support to the aeration grid shall be provided. No field welding shall be required.

4. Construction

- Welding: All welding shall conform to industry standard welding fabrication procedures. All factory welding shall undergo pickling/passivation to prevent rust and corrosion.

- Bolting: Where nothing to the contrary is indicated, bolts, screws, nuts, and washers shall be 18-8 stainless steel.

- Installation: The installation of the aeration equipment shall be such that upon completion of installation, all diffusers are level to ±1/8" of a common horizontal plane.

    i. Checkout: CONTRACTOR to provide an embedded benchmark location in each reactor along with its elevation as a means for comparing air grid elevations from one reactor to the next.

5. Design

- The system shall be designed to be submerged within the tank basin without deforming any component.

- All welded parts and assemblies shall be shop fabricated from 304L stainless steel with a 2D finish. Unless otherwise specified, all non-welded parts and pieces shall be shop fabricated from type 304 stainless steel with a 2D finish.

- All flanged joints shall have 45 to 55 durometer, Shore A, neoprene gaskets.

- All aeration grid and in-basin manifold supports shall be designed to compensate for a maximum floor elevation difference of ±3".

- All supports shall be designed to resist the load of the media in the event the tank is drained.

6. Airflow Control Valves (manual and modulating)

- Modulating Butterfly Valves

    i. SYSTEM SUPPLIER shall provide, and the CONTRACTOR shall install butterfly valves with actuators, one for each MBBR zone as shown on the contract drawings.

Qty:	1
Size:	12"
Valve Type:	Butterfly
Valve Style:	Lug
Operation:	Open/close
Actuator Type:	Double-acting pneumatic

Material:	Cast iron lugged body, aluminum bronze disc, 316SS stem
Seat:	Viton

- Manual Butterfly Valves

ii. SYSTEM SUPPLIER shall provide manual butterfly valves for each drop pipe as shown on the contract drawings.

Qty:	As shown in drawings
Size:	12”
Valve Type:	Butterfly
Valve Style:	Lug
Operation:	Open/close
Actuator Type:	Double-acting pneumatic
Material:	Cast iron lugged body, aluminum bronze disc, 316SS stem
Seat:	Viton

2.4 SCREENS

A. General:

1. The SYSTM SUPPLIER shall furnish and the CONTRACTOR shall install cylindrical screen(s) for media retention in the basin(s) as shown and specified. The Equipment Manufacturer shall furnish the items listed below:

   - Cylindrical Screens
   - Flat Screens
   - Air Sparge System
   - Supports

B. Equipment:

1. Cylindrical Screen

   - Cylindrical Screens shall be constructed of 304/304L stainless steel and shall be provided for the basins as shown on the contract drawings.
   - Design and supply of screens and supports shall be provided by the SYSTEM SUPPLIER.

- Cylindrical Screen (Perforated Plate): 304/304L stainless steel cylindrical screens shall be provided for the basins as shown on the contract drawings. The cylindrical screens shall be constructed of a minimum 14 gauge sheet and have a perforation pattern of 5/8" dia. with 13/16" centers on a staggered spacing. Each screen will have a minimum 1/4" thick plate mounting flange with two sets of anchor holes for wall mounting.

2. Sparge Air Scour Piping

    - 1-inch diameter 304/304L stainless steel air scour piping will be provided for each cylindrical screen as shown on the contract drawings. The air scour piping shall be tapped from the main air line inclusive of manual isolation valves.

    - Sparge piping shall be rated for continuous operation.

3. Flat Screen

    - A 304/304L stainless flat screen(s) shall be provided for the basin as shown on the contract drawings. The flat screen shall be constructed of a minimum 14 gauge sheet and have a perforation pattern of a 5/8" dia. with 13/16" centers, on a staggered spacing. Each screen will mount directly to the wall.

4. Construction

    - Welding: All welding shall conform to industry standard welding fabrication Procedures. All factory welding shall undergo pickling/passivation to prevent rust and corrosion.

    - Bolting: Where nothing to the contrary is indicated, bolts, screws, nuts, and washers shall be 18-8 stainless steel.

    - Installation: Each cylindrical screen shall be mounted directly to the concrete wall with (8) 18-8 stainless steel threaded rods with a minimum diameter of 3/8". Where cylindrical screens have spargers, screens shall be installed so that all air scour piping within the system is level to ±1/8" of a common horizontal plane. Where cylindrical screens do not have spargers, screens shall be installed so that they are level to ±1/4" of a horizontal plane.

5. Design

    - The system shall be designed to be submerged within the tank basin without deforming any component.

    - All welded parts and assemblies shall be shop fabricated from 304L stainless steel with a 2D finish. Unless otherwise specified, all non-welded parts and pieces shall be shop fabricated from type 304 stainless steel with a 2D finish.

    - The cylindrical screens shall be designed to handle the combined peak hour flow, RAS flow, and internal recycle flows.

    - Screen design loading rate shall not be more than 23 gpm/sf of screen surface

area.

- Screens shall have a minimum of 50% open space.

- Maximum headloss through the cylindrical screens shall not exceed 3” in each basin at peak hydraulic flows.

2.5 ANCHORS

A. General:

1. The CONTRACTOR SHALL furnish anchoring hardware for the supplied equipment.

- The CONTRACTOR SHALL furnish anchoring hardware for the supplied equipment.

- The CONTRACTOR shall furnish all epoxy and dispensing equipment for chemical anchoring.

PART 3 –EXECUTION

3.1 SHIPMENT, HANDLING AND STORAGE

A. The CONTRACTOR shall be responsible for receipt, protection and storage in accordance with manufacturer’s recommendations of all items shipped to the site from the time of delivery until installation is completed and the units and equipment are ready for operation. The equipment shall be suitably covered and protected at all times. Sufficient blocking shall be provided to prevent noticeable sagging of stored materials between supports and to prevent permanent distortion of the equipment. No iron or steel tools shall be allowed to come into contact with stainless steel components during handling and storage of the equipment. The CONTRACTOR shall follow manufacturers’ instructions to exercise any stored rotating equipment.

3.2 INSTALLATION/STARTUP

A. The CONTRACTOR shall install the equipment specified herein in accordance with the manufacturers’ instructions and recommendations.

3.3 SYSTEM START-UP, TESTING, AND CERTIFICATION

A. The SYSTEM SUPPLIER shall provide five (5) days of service in not less than two (2) trips by a fully qualified service engineer to inspect the installed equipment, assist the CONTRACTOR to start the equipment operation.

B. The SYSTEM SUPPLIER in conjunction with the installing contractor shall inspect equipment furnished by the SYSTEM SUPPLIER and provide certification on the installation. This certification shall be limited to the visual inspection and known quantitative aspects of the SYSTEM SUPPLIER’s equipment.

C. Instruments and other devices that require calibration and checkout will be carried out after the contractor has the equipment installed and verified continuity, hooked up electrically where/if required. Instruments and devices shall be configured and demonstrated to function prior to start-up. A document indicating the set points and calibration shall be furnished for documentation records.

D. The contractor shall furnish all consumables, including oil and grease, prior, to operation of equipment. All consumables after beneficial occupancy will be by the owner.

E. Operation, maintenance and installation manuals shall be provided for the supplied equipment. A total of five (5) copies shall be furnished.

3.4 TRAINING

A. The SYSTEM SUPPLIER shall provide on-site training to the OWNER's plant personnel.

B. The training services shall comprise of a qualified representative to instruct and train plant personnel in the proper startup, operation, shutdown, maintenance, repair and troubleshooting of the system. The O&M Manual shall be the primary training tool with supplemental training provided from a presentation. Mechanical equipment suppliers will also provide training on their specific equipment.

C. A training outline shall be submitted to the ENGINEER for approval including the credentials of the training staff.

D. The training shall include the following topics:

1. Theory of Operation
2. Actual Operation
3. Mechanical Maintenance
4. Electrical Maintenance
5. Instrumentation
6. Optimum Operation
7. Troubleshooting
8. Hands-on
9. Question and Answer Session

END OF SECTION 463350

SECTION 464141 – LINEAR MOTION SLUDGE MIXER

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall furnish, install, adjust, paint and test one (1) LM™ mixer for installation on the new 80 ft diameter digester, having one (1) mixer per digester. The LM™ Mixer shall be supported from the tank cover and shall be capable of mixing fluid within the tank as shown on the drawings.

B. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, and properly match-marked for ease of field erection.

1.2 DESCRIPTION

A. The dimensions and design parameters of the tank where the mixer shall be installed are listed below:

Number of Digester	One (1)
Cover Type	Fixed Steel
Tank Diameter	80 ft
Top of Tank Elevation	28.50 ft
Mixer Mount Elevation	27.50 ft
Maximum Liquid Level Elevation	25.50 ft
Minimum Liquid Level Elevation	0.00 ft
Bottom of Wall Elevation	28.50 ft
Cone Height	12.00 ft
Volume	1,153,000 gal
Solids Concentration	<6%

B. Each LM™ mixer assembly shall have the following characteristics:

Maximum motor name plate rating	10 hp
Stroke length	16 inch
Disk shape	Hollow, Flat Circular Ring (no exceptions)
Cycle time (Cycles per minute)	Approx. 30 cpm

1.3 GENERAL INFORMATION

A. All welding, both shop and field, shall be shielded arc welding and shall conform to the latest edition of the American Welding Society (AWS) D1.1 and D1.6.

B. The mixer wetted parts are either epoxy-painted mild steel or stainless steel, conforming to the requirements of "Standard Specifications for Steel for Bridges and Buildings".

C. The mixer Manufacturer shall not be responsible for verifying the existing condition of the cover or confirm if the cover can support the dynamic and dead loads created by the installed mixer.

D. The contractor shall provide the mixer Manufacturer details of the mounting flange where the mixer will be mounted.

1.4 MANUFACTURERS

A. The equipment covered by these specifications is intended to be standard equipment of proven performance as manufactured by reputable companies. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings. Manufacture shall coordinate with digester lid supplier to ensure compatibility with the supplied linear motion mixer.

B. Acceptable Manufactures:

1. OVIVO USA, LLC (basis of design)
2. Or approved equal.

C. The Manufacturer shall provide a history of being regularly engaged in the design, manufacture, project management, execution, shipment, field inspection and startup services of mixers, as defined in this specification.

D. Manufacturer must have a minimum of ten (10) mixer mechanisms of similar size, design and capacity of the specified equipment in satisfactory operation for a minimum of five (5) years. Manufacturer must meet the experience clause. No exceptions will be allowed.

E. Manufacturer must have test data from existing plants with an LiCl test report verifying the mixing efficiency of a similar sized mixer.

1.5 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 013000 "Submittals" the Contractor shall submit design data, support details and detailed erection drawings of the mixers and their attachment to the existing covers to the Engineer for review.

B. Fabrication of the LM™ Mixer and associated component shall not begin until the Engineer has approved the design data, design calculations, and details.

C. Submittal shall include at least three (3) full-scale field performance mixer tracer test reports using Lithium Chloride tracer. Such tests will have been previously conducted on an installation using in a single digester of at least 80 ft diameter or greater. Lithium chloride shall be added in sufficient quantity to achieve a concentration of at least 2 mg/l as Lithium in the digester to initiate the tracer test. Several samples shall have been taken over the two hydraulic retention durations (HRT), with a minimum of twelve (12) samples taken during the first twenty-four (24) hours of the tracer test. The results of these tests shall indicate high mixing efficiency with an active volume of 90% or greater.

D. The mixer manufacturer shall include as an integral part of the submittal, a Computational Fluid Dynamics (CFD) analysis for the specific tank configuration

where the mixer will be installed. The mixing analysis shall simulate the flow patterns generated by the reciprocating disk motion. Fluid velocity plots showing the flow patterns shall be provided. A table of the fluid velocities produced by the mixer that illustrate the active volume percentage shall be provided. A submittal lacking this site-specific analysis will be considered non-conforming and will be rejected.

E. In addition to the test reports, the manufacturer must submit a list of not less than ten (10) mixer installations, operating for a minimum of five (5) years, using a linear motion mixer and meeting the requirements of these specifications. These installations will be provided with contacts and telephone numbers to determine suitability of equipment submitted. No exceptions will be allowed.

1.6 SHOP TEST/OPERATION AND MAINTENANCE MANUAL

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in Section 01300 "Submittals".

B. An O&M manual shall be submitted for approval. Final manuals shall include information regarding the shop testing of each mixer. The testing information shall include as a minimum the following:
   1. Run the mixer drive unit in the shop for at least 2 hours.
   2. Inspect the mixer for any signs of unusual wear on bearings or wear surfaces.
   3. Check the cam system for operation without interference and friction.
   4. Make all final adjustments as required prior to shipment.

1.7 SERVICES OF MANUFACTURER’S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined in the General Conditions and Section 01650 "Facility Start up and Commissioning".

B. The services of the manufacturer's representative shall be provided for a period of not less than three (3) days as follows:
   1. One (1) trip of two (2) days to start-up and instruct operations personnel.
   2. One (1) trip of one (1) day to inspect completed installation.

C. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Resident representative on the day he is at the project.

PART 2 - PRODUCTS

2.1 GENERAL

A. The equipment to be provided with each mixer shall include the mixer disk, shaft, lubrication system, liquid seal, mounting base, cam drive system, local control

switch , main control panel with motor starters, adapters, fasteners, and accessories. The mixer drive assembly shall be removable as a unit without varying the normal liquid level or gas pressure within the tank.

2.2 MIXER DRIVE

A. The motor drive assembly shall consist of an explosion-proof, single-speed motor, and a planetary gearbox driving a cam-scotch-yoke mechanism that vertically moves the hydro-disk shaft. The mixing disk and shaft shall be constructed of 304L Stainless steel.

B. The mixer drive enclosure shall include a hinged door complete with a window to allow access to the yoke mechanism.

C. The mixer shall be designed to create a vertical "up and down" motion of the hydro-disk producing a vertical axial flow in the center of the disk, in both up and down directions.

D. The mixer disk shall be mounted at the end of the vertical drive shaft. The disk shall be a hollow circular ring (no exceptions allowed). All other designs are not acceptable and shall be strictly enforced.

E. The motor for the mixer shall be designed, manufactured, and tested in accordance with the latest edition of NEMA MG 1. The motor shall conform to the following:

Type	Single-speed, reversible, explosion-proof. Class I, Division 1, Group D
Electrical	230/460 volts, 3 phase, 60 hertz
Horsepower	10 hp
Motor Speed	1800 rpm
Min. motor efficiency at high speed	88 %
NEC code	T2A or T3C
Temperature Rating	Up to 40 °C

2.3 LIQUID SEAL SYSTEM

A. The liquid seal shall be mounted to the mixer mounting plate to create a gas-tight connection during normal operating conditions of the tank (normal liquid level and operating pressure).

2.4 MOUNTING PLATE

A. The mounting plate shall be designed to support the entire weight of the LM™ mixer and the liquid seal system.

B. The mounting plate shall be designed to support and transfer all dynamic and dead loads imposed by the mixer to the cover.

C. The mixer manufacturer shall supply a fabricated steel mixer mounting plate designed to be attached to the existing structural opening or mounting ring. The mounting plate shall be provided with the necessary flange bolts and gaskets.

2.5 MIXER CONTROLS

A. There shall also be provided a local switch:
   1. NEMA 7,
   2. On/Off/Auto

B. A wall mount control panel for control of the LM™ mixer shall be provided. The panel shall be mounted in a non-rated location building and include the following for proper mixer operation:

   1. NEMA 12, enclosure for mounting inside the control building
   2. On/Off/Auto switch
   3. Power and run indicator lights
   4. Motor starter
   5. Disconnect
   6. Amp meter
   7. Temperature measuring transducer to monitor the temperature of the mixer
   8. Switching amplifier for monitoring the limit switch(es) on the mixer
   9. Vibration sensor

2.6 LADDER AND WORKING PLATFORM

A. The linear motion mixer manufacturer shall furnish a working platform around the mixer. The platform is approximately 8 ft x 8 ft in size including handrail and grating. Refer to the project drawings for additional details.

B. The access ladder shall be securely mounted to the platform framing made out of aluminum.

2.7 SPARE PARTS

A. Furnish one (1) set of extra materials matching products installed for each set as described below:
   1. Four (4) Mixer Sliding Blocks
   2. Two (2) Mixer Rails
   3. Four (4) Auto Greasers
   4. One (1) Cam-Follower Assembly

B. Spare part shall be packaged for long-term storage and labeled with the name and number of the equipment to which it belongs.

PART 3 - EXECUTION

3.1 ANCHOR/ASSEMBLY BOLTS

A. All flange bolts shall be made of 304 stainless steel with the exception of the high strength fasteners for the mixer which shall be in accordance with the manufacturer’s recommendations.

3.2 FINISHES

Submerged Surface	
Surface Preparation:	SSPC-SP-10/NACE 2 (near-white blast) with 1.5 mils minimum angular anchor profile
Prime Coat:	Tnemec Series 61 Tneme-Liner to 8-12 mils DFT. Color: 5002(Beige)
Finish Coat:	Tnemec Series 61 Tneme-Liner to 8-12 mils DFT. Color: 5001(Gray)
Non-Submerged Surface	
Surface Preparation:	SSPC-SP-10/NACE 2 (near-white blast) with 1.5 mils minimum angular anchor profile
Prime Coat:	Tnemec Hi-Build Epoxoline II N69 or N69F to 4-6 mils DFT. Color: 00WH (Tnemec White)
Intermediate Coat:	Tnemec Hi-Build Epoxoline II N69 or N69F to 4-6 mils DFT. Color: 34GR (Deep Space)
Finish Coat:	Tnemec Endura-Shield Series 73 to 3-5 mils DFT. Color: 26BL (Clear Sky)

A. Any field touch up of the mixer mechanism shall be performed by the Contractor as directed in DIVISION 9 of the Contract Documents.

3.3 TESTING

A. The Contractor shall inspect the mixer after installation in accordance with the manufacturer's "Field Service Check List".

B. The Contractor, assisted by the manufacturer, shall field verify the following items as a minimum:

1. Motor installed and appropriately mounted for operation.
2. Mixer motion speed.
3. Mixer crank direction.
4. Amperage measurements not exceeding nameplate rating.
5. Assembly bolts tightened properly.

6. Unit install properly and shaft is plumb.

C. The Contractor shall correct any functional deficiencies. The Contractor shall provide all labor, water and other materials necessary to complete the field testing and verification. Completed inspection reports shall be submitted to the Engineer.

END OF SECTION

464300 - CIRCULAR SPIRAL SCRAPER CLARIFIER

PART 1 GENERAL

1.1 SCOPE

A. There shall be furnished and installed equipment for one (1) circular spiral scraper cage drive clarifier. The equipment shall include a walkway bridge, drive platform, center column, center cage, dual gate EDI, feedwell, full radius rake arms, skimmer blade & supports, hinged skimmer assembly, scum box & supports, scum flushing valve, effluent weir, scum baffle & supports, electrical control panel, drive unit, anchor bolts & fasteners, rake arm with spiral blades, and all other appurtenances required or shown on the drawings.

1.2 DEFINITIONS

Continuous Running Torque: The 100 percent AGMA torque to be continuously applied 24 hours a day to the drive system.

Momentary Peak Torque: The maximum torque rating of the drive mechanism components. Momentary peak torque shall be 2.0 times the continuous running torque.

Average Flow: The average flow per day for the whole year.

Design Flow: The average of the highest single day flows per month for the whole year.

Maximum Flow: Average flow per day for the month with the highest flows.

Peak Flow: The highest single hourly flowrate.

Return Activated Sludge (RAS): The settled solids removed from the bottom of clarifier and recycled to the biological process upstream of the clarifier.

1.3 SUPPLIER

A. Acceptable Manufactures:

1. WesTech
2. Clearstream
3. approved equal

B. Equipment must be able to provide the specified features and to meet the specified operating conditions.

1.4 DESIGN CRITERIA

Design Criteria (per clarifier)	Unit	Value
Influent Flow Rates		
Average Flow	MGD	3
Design Flow	MGD	3.4995
Maximum Flow	MGD	5.25
Peak Flow	MGD	6
Tank Diameter	ft	75
Side Water Depth	ft	10
Freeboard	in	24
Bottom Slope	in/ft	1.75
Influent Column Outside Diameter	in	24
EDI		
EDI Diameter	ft	8
EDI Depth	ft	2
Feedwell		
Feedwell Diameter	ft	17
Feedwell Depth	ft	5
Scum Box Width	ft	4
Collector Tip Speed	fpm	11.3
Motor HP	hp	1
Torque		
Continuous Torque	ft-lbs	26500
Momentary Peak Torque	ft-lbs	53000
Ball Race Diameter Min	in	47
Drive Overturning Moment	ft-lbs	465,000

1.5 WARRANTY

A. A written supplier's warranty shall be provided for the equipment specified in this section. The warranty shall be for a minimum period of one (1) year from start-up or 18 months from time of equipment shipment, whichever comes first. Such warranty shall cover all defects or failures of materials or workmanship which occur as the result of normal operation and service except for normal wear parts (i.e. squeegees, skimmer wipers, etc.).

1.6 SUBMITTALS

A. Two copies of all materials required to establish compliance with these specifications shall be submitted for review. Submittals shall include at least the following:

1. General arrangement drawings showing all important details and materials of construction, dimensions, loads on supporting structures, and anchor bolt locations.
2. Descriptive literature, bulletins, and/or catalogs of the equipment.
3. Complete data on motors and speed reducers.
4. Wiring diagrams and electrical schematics for all control equipment to be furnished.
5. Calculations documenting the AGMA rating of the drive unit and life of the main bearing; prepared and signed by a registered professional engineer.
6. Complete descriptive information and electrical schematic for the torque overload device.
7. Complete sludge transport calculations substantiating the rake blade design, rake tip speed, and floor slope.
8. Complete process calculations substantiating the sizing of the center column and ports, EDI and outlets, and outer feedwell. These calculations shall be based on parameters from the manufacturers operating experience.

1.7 EXPERIENCE

A. The equipment supplier shall have at least 15 years of experience in the design, application, and supply of circular clarifiers in water or wastewater treatment plants, and shall submit a list of not less than 25 operating installations of clarifiers with spiral rake blades and EDI as evidence of meeting the experience requirement.

B. To show evidence of being able to provide the quality of equipment and services described in this specification, the equipment supplier shall submit their ANAB-accredited ISO 9001 quality system certification. AIAO-BAR accredited systems are not a recognized equivalent and are therefore specifically prohibited. The quality procedures shall provide for a means of qualifying all sub-vendors and shall specify that the fabrication facility is a critical vendor and shall require inspection. The quality system shall be audited on-site by a third-party independent registrar at least annually. Certification shall remain in effect throughout the project start-up. Mechanism shall be manufactured according to requirements of Machinery Directive 98/37/EC.

1.8 SHOP ASSEMBLY AND INSPECTION

A. The equipment specified herein shall be factory assembled as far as practical to verify that all mating parts can be field assembled. All mating parts shall be trial fit and match marked. The manufacturer shall submit certification of shop trial assembly and photographs of assembly before shipment. The customer and installing contractor shall be given the opportunity to witness the shop assembly.

B. Shop inspection shall be performed by a qualified inspector and certified by the manufacturer. The inspection shall be documented, and all deficiencies noted, corrected, re-inspected and final completion formally authorized. Final shipment authorization shall be by the manufacturer to ensure completion of all fabrication, assembly, and inspection requirements. Inspection records and evidence of inspector qualification shall be submitted to the owner upon request.

PART 2 PRODUCTS

2.1 GENERAL DESIGN

A. Description

A. The clarifier mechanism shall be of the center drive type, supported on a stationary influent column, with the flow entering at the bottom of the influent column and flowing upward into the energy dissipating inlet. The flow shall then proceed into the feedwell through gates arranged for impinged flow near the water level for further energy dissipation and settling. The clarifier shall be designed to remove settled sludge from the bottom of the tank and floating scum from around the periphery of the tank.

a. The clarifier shall perform the following integrated functions:

1) Dissipate energy and control localized currents.
2) Separate solids form the clear liquid.
3) Evenly withdraw the clear liquid.
4) Transport and thicken settled sludge.
5) Prevent sludge dilution at withdrawal point.
6) Remove scum from the clarifier surface.

B. Materials

1. All structural steel shall conform to AISC – Steel Construction Manual latest edition. All steel plates shall conform to ASTM A36. All structural steel shape series of M, MT, S, ST, C, MC, and L shall conform to ASTM A36. Structural steel shapes W, WT, HP shall conform to ASTM A992/A572. All pipe shall be ASTM A53, Grade B. All square and rectangular tubing shall be ASTM A500, Grade C, unless otherwise noted. Steel members in contact with liquids, either continuously or intermittently, shall have a minimum thickness of 1/4 inch unless otherwise noted. All aluminum shall be type 5052, 6061, 6063, or 2014 alloy unless noted. All stainless steel shall be ASTM A276 for rolled shapes, ASTM A1069 for laser-fused shapes, ASTM A312 for pipe, ASTM AA554 for HSS and ASTM A240 for plate, type carbon steel unless noted.

Component Location	Material of Construction
Submerged	Carbon Steel
Non-Submerged	Carbon Steel

C. Fabrication

1. Shop fabrication and welding of structural members shall be in accordance with the latest edition of the "Structural Welding Code", AWS D1.1, (AWS D1.2-Aluminum, AWS D1.6-Stainless Steel), of the American Welding Society. All joined or lapped surfaces shall be completely seal welded with a minimum 3/16 inch fillet weld. Intermittent welding shall not be allowed, except on non-ferrous metals.

D. Edge Grinding

1. Sharp projections of cut or sheared edges of ferrous metals shall be ground to a radius by multiple passes of a power grinder as required to ensure satisfactory coating adhesion.

E. Shop Surface Preparation/Coating

1. All iron and steel surfaces, except the drive unit, shall be field cleaned and painted by the contractor to ensure paint compatibility and assign unit responsibility for the coating system. The drive unit shall be coated with the supplier's standard enamel paint system.

F. Structural Design

1. All steel design shall be in accordance with the AISC Manual of Steel Construction, latest edition and the International Building Code (IBC), latest edition.

2.2 DRIVE UNIT

A. Design Parameters

1. The drive unit shall be designed and manufactured by the clarifier equipment supplier to ensure unit responsibility. The drive unit shall be designed for the torque values previously listed. It shall turn the mechanism at the design collector tip speed. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L 10 life of 50 years or 438,000 hours. The drive unit shall be capable of producing and withstanding the previously listed momentary peak torque while starting. The drive main gear shall be designed to a minimum AGMA 6 rating when rated in accordance with the latest AGMA standard. Gear teeth shall be designed for proper load distribution and sharing. Stub tooth design and surface hardening of the main gear shall not be allowed. The main bearing shall be capable of withstanding the listed overturning moment without the aid of any underwater guides or bearings to ensure correct tooth contact for AGMA rating of the main gear.

    a. All spur gearing shall be designed to the latest AGMA spur gear standard for strength and surface durability, based on a life of 175,000 hours. The design running torque rating of the drive gearing shall be based on the smaller of the strength and durability values determined from the above AGMA standard. To ensure safety and ease of maintenance, all components of the drive shall be direct coupled.
    b. No overhung pinions shall be allowed on the speed reducing unit. The lower pinion bearing shall not be located below the turntable base.
    c. Any and all welding on the drive unit shall be done using E70XX weld rod.

B. Physical Characteristics

1. The drive unit shall consist of a solid internal main spur gear, bearing turntable, pinion, secondary speed reducer, support base, and drive unit bearing. The drive shall be mounted on the center column and support the entire rotating load of the mechanism. The main internal gear shall be forged of alloy hardened steel. The pinion shall be heat treated alloy steel. Support base for the drive shall be of welded steel to assure rigidity. Dust shields shall be provided. The drive bearing shall include a forged steel precision gear/bearing set, with fully contoured raceways hardened to a minimum 58 62 Rc and protected by a neoprene seal. The drive shall be designed so that the balls and nylon spacers can be replaced without removing the access walkway. The main gear to pinion gear mesh shall be oil lubricated. An oil sight glass, fill pipe, and drain shall be provided for the reservoir. Lubrication fittings shall be readily accessible.

C. Overload Protection

1. An overload device shall be provided in a stainless steel, weatherproof enclosure. The device shall be actuated by torque generated from the main drive, which shall operate two independently adjustable switches (the alarm switch at 100 percent of design running torque and the motor

cutout switch at 120 percent of design running torque). Devices that require the worm to float and measure the thrust of the worm gear shall not be acceptable. These two switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque indicator shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 160 percent of design running torque.

D. Turntable

1. The turntable base shall have an annular bearing raceway upon which the rotating assembly rests. It shall have a maximum allowable deflection in accordance with the bearing specifications. The allowable modulus of elasticity shall be a minimum of 29 x 106 psi. The center cage shall be fastened to and supported from the gear casing. Ball bearings shall be of high carbon chrome alloy 52100 steel running in fully contoured races, as part of a precision gear/bearing set. The balls shall be grease lubricated and protected by elastomer seals. Felt seals that allow the entrance of moisture from outside the drive (i.e. rain water, condensate, etc.) will not be allowed.

E. Speed Reducing Unit

1. The speed reducing unit shall consist of cycloidal, helical, or planetary speed reducers directly connected to a motor without the use of chains or v belts, and shall be keyed to the pinion.
    a. The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing on the high speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The lobes of the cycloid disc shall engage successively with pins in the fixed ring gear. The movement of the cycloid discs shall be transmitted then by pins to the low speed shaft. Speed reducer efficiency shall be a minimum of 90% per reduction stage.
    b. Speed reducer helical or planetary gearing shall be manufactured to AGMA standards and shall provide at least 95% power transmission efficiency per stage. The speed reducer shall have a minimum service factor of 1.25 based on the output torque rating of the drive.
    c. The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and be grease lubricated. As a safety feature, the speed reducer shall be back drivable to release any stored energy as the result of an over torque condition.

F. Motor

1. The motor shall be a squirrel cage, induction type, TEFC, ball bearing heavy duty unit of ample power for starting and operating the mechanism without overload, with a minimum service factor of 1.15.
    a. Power supply to the equipment shall be 240/480 volt, 60 hertz, 3 phase.

2.3 WALKWAY AND PLATFORM

A. Walkway

1. One (1) 36 inch wide walkway and platform with handrails shall be supported by the drive unit and influent column at the center and the tank wall at its outer end, and shall be designed to safely withstand a live load of 50 pounds per square foot. Deflection shall not exceed L/360 when both the dead load and live loads are applied. It shall consist of two trusses or beams with 1 1/4 inch

aluminum I-bar grating between the trusses or beams. The walkway shall be diagonally braced against lateral movement, and provided with handrails 42 inches high, of double row 1 1/2 inch diameter horizontal aluminum pipe, and 4 inch high kickplates on both sides. Walkway trusses may serve as the handrail if the top chord is 3 feet-6 inches above the walking surface.

a. Stainless steel bearing plates, UHMW-PE slide plates, and anchor bolts for the wall support shall be provided by the equipment supplier and installed by the contractor. Bearing plate dimensions and anchor bolt diameter, length, quantity, and arrangement shall be per the equipment supplier. The contractor shall block out or otherwise modify the tank or support structure to accommodate walkway and supports, if required.

B. Center Drive Platform

1. A center drive platform shall be provided which allows 24 inches of clearance outside the center drive components. It shall consist of 0.25 inch aluminum checkered plate with necessary stiffeners and supports, resting on the drive unit and center column, and provided with connections to the walkway. The entire platform shall be surrounded by handrails 42 inches high of double row 1 1/2 inch diameter horizontal aluminum pipe with 4 inch high kickplates.

2.4 INFLUENT AND SLUDGE REMOVAL

A. Stationary Center Influent Column

1. A stationary cylindrical steel influent column of 1/4 inch minimum wall thickness shall be provided. One end shall have a support flange for bolting to the tank floor over the influent line, with a similar flange at the top for supporting the drive unit and walkway. The structure and anchor bolts shall provide adequate support for the entire mechanism dead load plus live loads and torque with an adequate factor of safety to eliminate excessive deflection or vibration. Suitable openings shall be provided in the upper portion of the column just below the sludge collection box to allow unrestricted passage of the flow into the energy dissipating inlet.

2. Prior to the center column being grouted in place, the drive unit shall be installed, positioned, and leveled.

B. Dual Gate Energy Dissipating Inlet

1. A dual gate rotating circular energy dissipating inlet with bottom shall be supported by the cage and be designed to diffuse the liquid into the feedwell in an impinged flow direction without excessive disturbance or formation of vertical velocity currents. The DG-EDI shall be designed to positively prevent sludge from depositing within the DG-EDI and shall include bottom drain holes.

a. The diameter, depth, and detention time of the DG-EDI shall be included in the submittal with the design calculations and shall show proper process application as evidenced by the required successful operating installations.

b. The rotating DG-EDI shall be designed with a full bottom extending to within 1 inch of the center column. It shall include an upper rim angle for stiffness. Multiple, discharge ports shall be provided to induce impinged flow. The gates shall have a fixed bottom to prevent vertical currents as the flow exits the DG-EDI.

c. The DG-EDI shall be made of not less than 3/16 inch thick steel plate with necessary stiffening angles.

d. EDI Test Data – The submittal shall include data from side-by-side tests on identical full-scale operating clarifiers at least 100 ft. in diameter, with identical feed and underflow rates. The data shall show that installation of an EDI equivalent in design to that proposed for this project produced a decrease in effluent suspended solids of at least 25 percent.

C. Feedwell

1. The flocculating feedwell shall be located outside of the EDI to diffuse the liquid into the tank without disturbance or formation of velocity currents. Baffled openings shall be provided near the water surface to allow scum to exit the feedwell.

    a. The supports for the feedwell shall be located either above the liquid extending from the cage or bridge, or on the rake arms. Submerged supports from the rake arms shall be designed to minimize horizontal flow disruption.
    b. No feedwell support or feedwell spliced connection shall be contained within the annular space formed between the feedwell and EDI. The depth of the feedwell shall be such as to provide proper detention time and an exit velocity at maximum flow that will not scour the settled sludge. The diameter, depth, detention time, and exit velocities shall match the process application calculations as evidenced by the required successful operating installations.
    c. The feedwell shall be made of not less than 3/16 inch thick steel plate with necessary stiffening angles.

D. Center Cage

1. The center cage shall be of steel box truss construction. It shall be provided with connections for the two sludge rake arms and feedwell supports if required. The cage top shall be bolted to the main gear which shall rotate the cage with the attached arms and feedwell. The cage and each arm shall be designed to withstand 150 percent of the design running torque of the drive without over stressing the members. Loading to develop the torque shall be considered as uniform loads applied to each arm individually.

E. Spiral Blade Rake Arms

1. The mechanism shall include two long sludge rake arms of steel truss construction with spiral shaped steel scraper blades and adjustable stainless steel squeegees. Squeegees shall be fastened to the rake blades with stainless steel fasteners.

    a. Scraper blades shall be designed for sufficient sludge transport capacity to handle the design solids loading rate, with the depth of the blade varying from a minimum at the tank periphery to a maximum at the tank center.
    b. Blades shall properly convey settled sludge to the sludge withdrawal point. The arms shall be adjustable at the cage to assure an even grout thickness over the tank bottom.
    c. The rake speed shall be sufficient to transport the necessary volume of sludge to the sludge outlet, but shall not re-suspend settled sludge.

2.5 SCUM SKIMMING

A. General

1. The clarifier manufacturer shall furnish two (2) skimming device(s) as part of each clarifier mechanism. Each skimming mechanism shall be arranged to sweep the surface of the

sedimentation compartment, automatically removing scum and floating material to a scum box at the periphery of the tank.

B. Skimmer Construction

1. The rotating scum skimmer shall include a horizontal steel plate skimmer blade supported by vertical steel members extending up from the rake arms. The blade shall extend from a point 6 inches away from the influent feedwell to the hinged scum skimmer assembly at the tank periphery.

C. Scum Skimmer Assembly

1. A hinged scum skimmer assembly shall be mounted on the outer end of the skimmer blade. The hinged scum skimmer assembly shall be designed to form a pocket for trapping the scum. The hinged arrangement shall insure continual contact and proper alignment between wiper blade, scum baffle, and ramp as the blade travels up the scum box ramp. The wiper blade shall have a wearing strip on its outer end which contacts the scum baffle and a neoprene strip on its lower and inner edge. The neoprene wipers shall be a minimum 1/4 inch thickness. The scum is trapped as the wiper blade meets the ramp and is raised up the ramp to be deposited into the scum trough for disposal.

D. Scum Box

1. The scum box shall be of the size specified, supported from the tank wall and connected to the scum withdrawal piping. It shall be made of 1/4 inch thick welded steel plate. The box shall have a scum trough, vertical steel sides, and a sloping approach ramp that extends from 1-1/2 inches above water level to 5-1/2 inches below. A similar ramp shall be provided at the opposite end to allow the skimmer blade to lower back to the operating position. A flexible connector shall be provided for connection to the contractor supplied scum withdrawal piping in the tank wall.

E. Scum Flushing Valve

1. A valve shall be attached to the scum box which automatically opens and allows clarified liquid into the scum box to flush out solids. The valve shall actuate at every pass of the scum skimmer over the scum box, allowing sufficient delay after deposit of the solids before flushing begins. Delay and flush duration shall be adjustable. The opening and closing of the scum flushing valve shall be one smooth continuous movement. The valve shall provide 2 to 5 gallons of flush water per each pass of the skimmer assembly.

2.6 CLARIFIER ACCESSORIES

A. Launder

1. A rectangular effluent launder shall be provided around the perimeter of the tank. The launder shall be formed as part of the concrete wall. A drop out box shall be provided in the bottom of the launder at one point for collection and discharge of the clarified effluent.

B. Scum Baffle

a. The baffle shall consist of 0.25 inch thick x 12 inches deep FRP sections. In the area of the scum box the scum baffle shall extend to 12 inches starting approximately 6 feet before and ending 2 feet after the scum box. The baffle sections shall be curved

and fastened to the launder wall with adjustable FRP support brackets, stainless steel fasteners, and anchor bolts.

C. Weir

1. An adjustable weir shall be provided around the periphery of the tank at the water surface for removal of clarified effluent.

    a. The weir shall consist of 0.25 inch thick x 9 inches deep fiberglass sections with 2.5 inch deep 90 degree v notches at 6 inch intervals. The weir sections shall be curved and fastened to the launder wall with special large washers, anchor bolts, and hex nuts to allow vertical adjustment.

2.7 ELECTRICAL

A. The Clarifier manufacturer shall be provide a NEMA 4X, 304 stainless steel control panel to control and protect the Clarifier mechanism. The control panel shall be wired to accept a 480-volt power feed, a control power transformer shall be provided to power all internal controls. The control panel shall be built in a UL508A/698 certified panel shop.

B. The control panel shall be provided with the following devices mounted on the exterior of the enclosure:

1. Top mounted amber strobing alarm light, Federal Signal LP3P.
2. Top mounted alarm horn, Federal Signal 350B.
3. Door mounted rotary disconnect handle, manufactured by Square D.
4. Door mounted red rake running light, Idec 30.5mm.
5. Door mounted amber torque cutout light, Idec 30.5mm.
6. Door mounted amber motor overload light, Idec 30.5mm.
7. Door mounted rake hand/off/auto 3 position selector switch, 30.5mm.
8. Door mounted red alarm silence pushbutton, Idec 30.5mm.
9. Door mounted black reset pushbutton, Idec 30.5mm.

C. The control panel shall be provided with the following devices mounted on the interior of the enclosure:

1. Molded case main breaker, Square D HDL series.
2. 250 VA control power transformer, Acme.
3. NEMA size 1, FVNR motor starter, Square D TeSys N series.
4. Control relays, Idec series RH.
5. Time delay relay, Idec series RTE.
6. Terminal blocks, Phoenix Contact series UT4.

D. The following signals shall be made available as dry contacts for remote monitoring by the plant SCADA:

1. Rake drive running.
2. Rake drive overload.
3. Rake drive in auto.
4. High torque alarm.
5. Cutout torque alarm.

E. Workmanship shall be of the highest quality with all wiring on the enclosure back panel routed through plastic wire way and all door routed wire securely fastened with adhesive feet and nylon ty-wraps. Wires that cross enclosure hinges shall be protected with nylon spiral wrap and must have adequate slack to allow the door to open 180 degrees. All components on the back panel shall be mounted using #14 machine screws. Rivets and self-tapping screws are not acceptable.

F. The control panel shall be mounted by the electrical contractor on the platform handrail adjacent to the Clarifier drive unit. All conduit and wiring between the Clarifier control panel, drive torque monitor, power distribution system and the SCADA system shall be provided and installed by the electrical contractor.

2.8 ANCHORAGE AND FASTENERS

A. Anchor Bolts

1. All anchor bolts shall be a minimum of 1/2 inch diameter and made of type 304 stainless steel. The equipment supplier shall furnish all anchor bolts, nuts, and washers required for the equipment.

B. Fasteners

1. All structural fasteners shall be a minimum of 1/2 inch diameter and made of type 304 stainless steel. The equipment supplier shall furnish all fasteners required for the assembly of the equipment.

PART 3 INSTALLATION

3.1 GENERAL

A. The equipment shall be installed properly to provide a complete working system. Installation shall follow the supplier's recommendations.

3.2 MANUALS

A. The equipment supplier shall furnish an electronic copy of the operation and maintenance manual, which will be retained at the installation site to assist plant operators. The manual shall include the supplier's erection and assembly recommendations and a complete list of recommended spare parts.

3.3 FIELD SERVICE

A. The equipment supplier shall provide the service of a qualified representative for one trip and one day per mechanism to inspect the mechanism installation, assist in start up, and instruct plant personnel in the proper operation and maintenance of the mechanism.

3.4 FIELD TESTING

A. Torque Tests

1. The entire sludge collector mechanism shall be statically load tested by loading the rake arm with 150 percent of the specified design running torque. The test shall verify the torque overload control device settings for alarm and motor cutout. One truss arm shall be anchored and the load measured to demonstrate the rake arms', cage's, and drive unit's ability to withstand the specified torque. Sketches and calculations shall be submitted illustrating how the torque will be applied prior to the test taking place.

B. Operation Tests

1. The contractor shall operate the mechanism in a dry tank for a minimum of 4 continuous hours before flow is allowed to enter the system. There shall be no binding, jerky, or unusual motion exhibited during this run in period. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 4 hour observation test run. If the unit should fail under any of these conditions, the test shall be halted and the problem corrected. If, after several attempts, the unit does not successfully pass the field test, the faulty portion of the equipment shall be repaired or replaced and the test re-run.

END OF SECTION 464300

SECTION 465121 – COARSE BUBBLE DIFFUSERS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section includes the design, manufacture, installation, and start-up of a coarse bubble aeration system including in-basin aeration components as shown on the Drawings and as specified herein.

B. The aeration system manufacturer shall provide single source responsibility for the complete aeration system including in-basin piping, diffuser assemblies and support components.

1.2 DEFINITIONS

A. Tank: Vertical walled reactor within which aeration occurs.

B. Diffuser Unit: Fabricated unit including drilled diffuser support body which releases air to the water.

C. Diffuser Assembly: Wide band, nominal 24-inch-long stainless steel assembly with a 3/4" threaded connection.

D. Air Drop Pipe: Vertical piping section from out-of-basin header stub to in-basin aeration system.

E. Air Manifold Piping: Air distribution piping from drop pipe to air distribution headers.

F. Air Header Distribution Piping: Air distribution piping from air manifold and diffuser assemblies.

G. Air Header Piping: Out-of-basin air distribution piping from the blower building to the header stubs.

H. Blower Manifold Piping: Air distribution piping between the blower discharge and air header piping.

I. Aeration Grid: Associated piping and diffuser components connected to a single drop pipe.

J. Standard Cubic Feet per Minute (scfm): Air at 68°F, 14.7 psia and 36% relative humidity.

K. Maximum Pressure: Pressure in blower manifold piping at the specified airflow rate.

L. Oxygen Transfer Efficiency: Percent of oxygen in the air stream that is dissolved to the wastewater under specified conditions of temperature, barometric pressure, airflow rate, and dissolved oxygen concentration.

M. Standard Oxygen Transfer Efficiency: Percent of oxygen in the air stream that is dissolved to clean water under conditions of 68°F, 14.7 psia, and zero dissolved oxygen.

N. Air Distribution Uniformity: Variation in air distribution between diffuser assemblies.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. Design in-basin air piping and diffusers to diffuse air throughout the aeration tank(s) in accordance with the specifications.
2. Design each diffuser assembly to provide uniform air release over the specified airflow range.
3. Design the aeration system to provide the minimum specified oxygen transfer efficiency at the specified airflow and operating pressure.

1.4 SUBMITTALS

A. General:

1. A detailed engineering submittal package shall be provided in sufficient detail and scope to confirm compliance with the requirements of this section. Submittals shall be complete for all required components. Partial submittals will not be accepted.

B. Shop Drawings:

1. Detailed layout drawings for in-basin aeration components. Layout drawings shall include:
   a. Layout and configuration of aeration system.
   b. Detail drawings of diffuser assemblies showing components, method of construction, and attachment mechanism to air header distribution piping.
   c. Detail drawings of all piping connections including drop to manifold, manifold to header and inline connections for manifold and headers.
   d. Detail drawings of pipe support components.

C. Product Data:

1. Detailed listing of materials and materials of construction.
2. Product literature.

D. System Design and Performance Data:

1. Include complete air headloss calculations for the aeration equipment from the top of the dropleg to the farthest diffuser bubble release point.
2. Design calculations showing uniform air distribution (+10% maximum variation) through lateral piping and diffuser element orifice system.
3. Design calculations for piping and support components.
4. Product Experience:
   a. The supplier shall have experience in the design, manufacture, supply and commissioning of coarse bubble aeration equipment identical to the type specified for this project.
   b. The equipment submitted shall be of proven design and shall be referenced by at least three installations.

c. If the Contractor elects to submit a substitute aeration system that does not comply with the above experience requirements, a bond guaranteeing the replacement of the aeration system shall be provided with the submittal package.
   1) The bond term shall be for a period of five (5) years. This term shall include the specified warranty period plus three (3) additional years.
   2) If the operation of the aeration system as determined by the Owner is unsatisfactory, the Contractor shall repair, modify or replace the entire aeration system in a manner acceptable to the Owner.
   3) Normal wear or malfunctions due to neglect or abuse shall not be considered justifiable reasons for unsatisfactory operations.
   4) The presence of chemical compounds that are aggressive to the membrane material are not considered as normal wear or service.
   5) If the Contractor fails to correct deficiencies identified by the Owner within six (6) months of the date first notified in writing, the Owner shall at its own discretion make all necessary repairs or replacement and deduct all associated costs from the Contractor's bond.

5. Guarantee:

   a. All equipment furnished under this contract shall be warranted to be free from defects in materials and workmanship for twelve (12) months from startup of the equipment or eighteen (18) months from shipment, whichever occurs first. Defective part(s) shall be remedied by repair or replacement of the defective part(s) only shipped freight included, FOB original shipping point, by the Manufacturer. Labor is excluded in this warranty.

E. Installation Instructions:

1. Installation requirements and guidelines for all proposed equipment shall be provided.
2. Information on the aeration system shall include but not be limited to:
   a. Diffuser unit assembly.
   b. Diffuser assembly attachment.
   c. Piping components and assembly.
   d. Piping support components.

F. Operation and Maintenance Data:

1. Operations and maintenance data for all proposed equipment shall be provided.
2. Information on the aeration system shall include but not be limited to:
   a. Air flow balancing.
   b. Diffuser assembly maintenance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Environmental Dynamics International, Columbia, Missouri.

B. Pre-approved equal.

1. Information on alternate manufacturers shall be submitted to the Design Engineer no less than 2 weeks prior to the bid date. Only pre-approved, named manufacturers are acceptable.

2.2 STAINLESS STEEL MATERIALS AND FABRICATION -GENERAL

A. Welded Stainless Steel

1. All welded parts and assemblies shall be fabricated from sheets and plates of Type 304L stainless steel conforming to the requirements of ASTM A240. Welds shall conform to the requirements of ASTM A774, Part 4.

B. All non-welded parts and assemblies shall be fabricated from sheets and plates of Type 304 stainless steel conforming to the requirements of ASTM A240.

C. All stainless steel pipe shall be fabricated from Type 304L material conforming to the requirements of ASTM A240. Stainless steel pipe fabrication shall conform to the requirements of ASTM A530, ASTM A554, and ASTM A778.

D. All stainless steel pipe fittings shall be fabricated from Type 304L material conforming to the requirements of ASTM A240. Stainless steel pipe fitting fabrication shall conform to the requirements of ASTM A774.

E. 316 stainless steel may be substituted for 304 based on project requirements.

F. Stainless steel bolts shall be 18 - 8 stainless steel.

G. Stainless steel nuts shall be 18 - 8 stainless steel.

H. Stainless steel washers shall be fabricated from Type 304 material conforming to the requirements of ASTM A240. Field welding of stainless steel pipe, fittings, fabrications or assemblies will not be permitted.

I. Field welding of stainless steel pipe, fittings, fabrications or assemblies will not be permitted. When field repairs are required, field welding may be permitted on a case review basis.

2.3 CORROSION PROTECTION AND FINISHING

A. Clean all welded stainless steel surfaces and welds after fabrication by using the following procedure:

1. Pre-clean all outside weld areas to remove weld splatter with stainless steel brushes and/or deburring and finish grind wheels.
2. Finish clean all interior and exterior welds and piping by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform

corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 and Section 8.3.

3. Corrosion protection techniques not utilizing full immersion methods are unacceptable and will be cause for rejection of the equipment.

PART 3 AERATION EQUIPMENT

3.1 DESIGN CONDITIONS AERATION BASINS

A. SOR = 400 pounds per hour each basin

B. SOTE = 17.1 %

C. Airflow = 2,700 scfm each basin

D. Diffuser Submergence Depth = 19 feet

3.2 THE DIFFUSER SYSTEM SHALL EMPLOY A MINIMUM OF ONE-HUNDRED FORTY (140) 24-INCH-LONG DIFFUSER UNITS EACH BASIN.

A. Stainless Steel Coarse Bubble Diffusers:

1. The EDI MaxAir coarse diffuser assembly shall be furnished and installed.
2. Diffuser units shall have nominal dimensions of 24 inches long and be constructed of 304L SS.
3. Inlet end to have an integral hex nut to be used for installation. Both inlet and discharge end plates to be constructed of 304L SS.
4. Diffuser body to be constructed from 22 gauge 304L SS.
5. Diffuser body to be continuously welded to the ends and the entire unit is to be passivated after assembly.
6. Diffuser unit shall be supplied, in standard form, with bottom welded deflector plate to prevent MBBR media and debris from entering the unit
7. Diffuser end incorporate a connection for installing end diffuser supports to protect from external forces larger than 7,500 inch-pounds.
8. Rail mounted diffuser support is acceptable, and shall consist of fiberglass rail and threaded anchor rods secured to the floor every 6 feet and hardware for connecting the FRP rail to the diffuser end.

B. Aeration System Piping:

1. Out-of-basin air piping including blower manifold, air header, and header stubs are required and are to be supplied by the Contractor.
   a. Header stubs shall extend to the inside top of the wall and terminate with a full diameter, vertical face, flange.

b. Out-of-basin piping may be unlined ductile iron, galvanized steel, stainless steel, or painted carbon steel.
c. The Contractor shall provide an isolating/balancing valve for control and distribution of air to the aeration grid and to allow isolating of the grid for inspection and maintenance on the header stub.
d. Isolation/balancing valve shall be positioned for accessibility from the top of the tank.

2. Drop pipe shall be provided with a flanged top connection and plain end.
   a. Drop pipe shall extend from the top connection to within 2 feet of the air manifold.
   b. Material of construction for the drop pipe shall be schedule 10, stainless steel.
   c. Drop pipe shall connect to air manifold piping by means of a wrap-around clamp adapter.
3. All submerged manifolds and header components shall be Schedule 10 304 SS minimum.
4. Diffuser connection on the piping shall be factory welded and include a minimum 2-3/8" diameter weld on the lateral piping. This negates the need for gussets which are used on small outlet connections welded to the lateral piping.
5. Pipe supports shall be all stainless steel construction.
   a. Supports shall accommodate longitudinal movement in the piping components due to the thermal expansion and contraction over a temperature range of 100°F.
   b. Supports shall restrain the axial and rotational movement of the pipe while providing for unrestrained longitudinal movement.
   c. Supports shall allow leveling of the air piping with 2 inch minimum vertical adjustment at each support.
   d. Each pipe support shall be connected to basin floor by at least 2 anchor bolts.
   e. The integrated pipe support assembly shall be designed to withstand the associated uplift force of the piping and diffuser assemblies with a minimum design factor of safety equal to ten (10).

C. Spare Parts:
1. The Contractor shall furnish the following spare parts and store as directed:
   a. Two (2) - EDI MaxAir diffuser assemblies completely factory assembled.

3.3 AIR SCOUR SYSTEM

A. Airflow = 75 scfm each basin

B. Drop pipe shall be provided with a flanged top connection and plain end.
   a. Drop pipe shall extend from the top connection to within 2 feet of the air manifold.
   b. Material of construction for the drop pipe shall be schedule 10, stainless steel.
   c. Drop pipe shall connect to air manifold piping by means of a wrap-around clamp adapter.

C. All submerged manifolds and header components shall be Schedule 10 304 SS minimum.

D. Air Lateral Diffuser piping shall be factory assembles with flanged field joints. Air Laterals shall include engineered air outlet orifices to provide air distribution of 95% minimum at the design airflow condition.

1. Pipe supports shall be all stainless steel construction.
    a. Supports shall accommodate longitudinal movement in the piping components due to the thermal expansion and contraction over a temperature range of 100°F.
    b. Supports shall restrain the axial and rotational movement of the pipe while providing for unrestrained longitudinal movement.
    c. Supports shall allow leveling of the air piping with 2 inch minimum vertical adjustment at each support.
    d. Each pipe support shall be connected to basin floor by at least 2 anchor bolts.
    e. The integrated pipe support assembly shall be designed to withstand the associated uplift force of the piping and diffuser assemblies with a minimum design factor of safety equal to ten (10).

PART 4 EXECUTION

4.1 INSTALLATION

A. Contractor shall furnish, inspect, store, and install aeration system and blower components in accordance with manufacturer's written instructions and approved submittals.

B. Diffuser assemblies on a common grid shall be installed within an elevation tolerance of ±1/2 inches.

C. Contractor shall provide all valves, air header piping, wall sleeves with seals, wall pipes, and concrete pedestals as necessary to complete the system as shown on the plans.

D. Air piping including blower manifold, header, and in-basin piping must be clean prior to delivering air up the diffusers.

E. Contractor shall be responsible for cleanliness of piping and may be required to manually clean pipe, or air or water flush piping as required.

4.2 START-UP

A. After installation is completed, the Contractor shall perform the following field tests in the presence of the Engineer and the Owner.

1. Fill the reactor to the bottom of the diffuser assemblies.
2. Adjust the pipe supports and diffuser assemblies such that all diffuser units are installed within ±1/2 inches of the design diffuser elevation.
3. Fill the reactor to a level of 2 feet above the top of the diffusers.
4. Release air to the system and inspect the system for air leaks at all piping or diffuser connections.
5. Adjust any piping or diffusers that show leaks or disproportionate amount of airflow.
6. Operate the blowers at the design air rate and observe air release and air distribution patterns.
7. All water, air, power and labor associated with testing and adjustment of diffuser assemblies are to be supplied by Contractor.

B. MANUFACTURER'S FIELD SERVICES

1. A manufacturer's representative shall be present at the job site to inspect the installation of the equipment, start-up the system, and train operations and maintenance personnel on the supplied equipment.
2. Services including a total of one (1) trip with a total of two (2) days onsite shall be provided.

END OF SECTION 465121

SECTION 467311 – FIXED DIGESTER COVERS

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall furnish, install, adjust, paint and test one (1) 80 F1 fixed steel cover for the digester tank. The digester cover shall be arranged as shown in the drawings.

B. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations and properly match-marked for ease of field erection.

1.2 DESCRIPTION

A. The dimensions and design parameters of the tank where the cover shall be installed are listed below:

Number of Digesters	One (1)
Tank Diameter	80 ft
Top of Tank Elevation	28.50 ft
Maximum Liquid Level Elevation	27.50 ft
Minimum Liquid Level Elevation	25.50 ft
Bottom of Wall Elevation	0.00 ft
Tank Height	28.50 ft

1.3 GENERAL INFORMATION

A. The cover shall all be made of structural grade carbon steel. The minimum thickness of the steel shall be ¼ in or 6 mm (metric equivalent).

B. The various steel components of the cover shall comply with the following standards:
   1. Structural Plates: ASTM A36
   2. Wide Flange Beams and T's: ASTM A992
   3. Channels: ASTM A36
   4. L-Angles: ASTM A36
   5. Tubes: ASTM A500 Gr C

C. All welding, both shop and field, shall be shielded arc welding and shall conform to the latest edition of the American Welding Society (AWS) D1.1 "Structural Welding Code - Steel" for carbon steel construction.

D. The Contractor's welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirements of American Welding Society (AWS) D1.1 "Structural Welding Code - Steel". The Contractor shall perform all field welding in conformance with information shown on the Equipment Manufacturer's drawings regarding location, type, size and length of all welds in accordance with the latest edition of AWS A2.4 "Standard Symbols for Welding, Brazing, and Nondestructive Examination" and special conditions as shown by notes and details.

E. The design of the steel digester cover does not fall under any specific code or standard. The current codes and standards should be used as guidelines for the design and analysis of the equipment. The analysis shall result in a conservative design that meets the intent of the present

codes and standards.

F. As noted above, the following governing codes and standards shall be used in the analysis and design:
   1. Overall Building Code: IBC 2018
   2. Minimum Design Loads: ASCE 7-16
   3. Concrete Code: ACI 318-14
   4. Steel Code: AISC 360-16

1.4 MANUFACTURES

A. The equipment covered by these specifications is intended to be standard equipment of proven performance. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings. The lid supplier shall ensure that the new cover is compatible with the LM™ Mixer by OVIVO USA, LLC as specified in Section 464100 – Linear Motion Mixer.

B. Acceptable Manufactures:
   1. Ovivo
   2. WesTech
   3. ODI
   4. Or approved equal.

C. The Manufacturer proposing to supply the digester covers shall have demonstrated ability to design and manufacture covers of this diameter and pressure conforming to these specifications. The Manufacturer shall provide a history of being regularly engaged in the design, manufacture, project management, execution, shipment, field inspection and startup services of arched, radial beam shell membrane design covers as defined in this specification. Manufacturers not meeting the following requirements will be rejected:

   1. The cover Manufacturer shall have designed and furnished not less than thirty (30) steel fixed covers of the same specified size or greater.

   2. The manufacturer shall have installed a minimum of ten (10) covers with the LM™ Mixer mounted on them. The Manufacturer's bid package shall include a list indicating the number, diameter and location of the covers.

   3. The person responsible for the design of the proposed covers shall be a Professional Engineer. The Professional Engineer shall have designed a minimum of ten (10) covers furnished by the Manufacturer, while employed by the Manufacturer. The Manufacturer shall submit with the cover bid, the name of the Professional Engineer and a list of the covers designed by that person for the Manufacturer. The bid shall not be considered responsive without this list.

   4. The Manufacturer proposing to supply the covers on this project shall be International Organization for Standardization 9001 Quality Systems (ISO 9001) certified.

1.5 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 "Submittals" the Contractor shall submit to the Engineer for review, design data, support details for appurtenances, design calculations stamped by a registered Professional Engineer in the state of Utah, and detailed shop drawings of the cover.

B. The Professional Engineer who performs the calculations for the equipment covered under this section shall have designed digester covers of similar diameters and operating pressures. Provide a list of designs prepared by the engineer.

C. Fabrication of the cover shall not begin until the Engineer has accepted the design data, design calculations, and details.

D. The Manufacturer's shop drawing shall clearly show complete information regarding location, type, size and length of all field welds in accordance with the latest edition of AWS A2.4 “Standard Symbols for Welding, Brazing, and Nondestructive Examination”. Special conditions shall be fully explained by notes and/or details.

1.6 OPERATION AND MAINTENANCE MANUAL

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in Section 01300 "Submittals".

B. Two copies of a preliminary or reference O & M manual from past projects shall be included in the shop drawing submittal. Without these manuals, the submittal will be considered incomplete and will be returned to the Manufacturer.

1.7 SERVICE OF MANUFACTURER’S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified Manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined in the General Conditions and Section 01650 "Facility Start up and Commissioning".

B. The services of the Manufacturer's representative shall be provided for a period of not less than three (3) days as follows:

1. One (1) trip of two (2) days to start-up and instruct operations personnel.
2. One (1) trip of one (1) day to inspect completed installation.

C. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The Manufacturer's representative shall sign in and out at the office of the Resident representative on the day he is at the project.

PART 2 - GENERAL

2.1 GENERAL

A. Loads used for the design of the cover shall come from the codes and standards noted in Part 1.3 of this Section. The cover shall be stable under all design load conditions, including localized static and dynamic loads. All structural members shall be designed to allow the cover to be self-supporting when resting in an empty tank on the corbels or on the tank wall with the maximum possible applied loading, as follows:

Dead Load	According to the Manufacturer's design
Ground snow	50 psf (Risk cat. III)
Design wind speed	120 mph (Risk cat. III)
Concentrated live load*	4,500 lbs
Vacuum load	2 in W.C.
Maximum internal design pressure	16 in W.C.
Mixer dynamic and static loads	As provided by mixer Manufacturer
Seismic load	Site specific (Risk cat. III)

* Note, the concentrated live load must be applied at location resulting in most conservative design outcomes.

B. Snow loading shall consider the following scenarios as required by ASCE 7: Uniform with drift, partial, and minimum uniform. Wind loading must consider vertical pressure loading on the domed cover as well as the code-prescribed minimum horizontal pressure on the projected area. For seismic analysis and design, the cover shall be considered as a “Non-building Structure Not Similar to a Building” as described in Chapter 15 of ASCE 7.

C. Load combinations used in the analysis shall come from ASCE 7 (referenced in Part 1.3 of this Section), taking into consideration the effects of omitting loads from combinations, where reasonable, to create a more conservative design.

D. Maximum allowable stresses shall not exceed the limiting stresses as set forth in the AISC 360 "Specifications for Structural Steel Buildings." (Referenced in Part 1.3 of this Section). The cover shall be designed as a shell design with support member and side skirt, radial beam members, thrust ring, center compression ring, and cover plates properly proportioned to match deflections and stresses.

E. The structural framework shall be arranged for complete assembly by field welding all pieces in place, followed by field welding of the framework and roof plates to provide a gastight and watertight cover. There shall be no bolt holes in the plates. Cover plates shall not span more than 8 ft between main radial beam members. The cover plates shall be welded to the top of the radial beams.

F. The side skirt sections shall consist of ¼ in or 6 mm (metric equivalent) plates with reinforcing members. The radial joints between cover plates shall be centered on the radial beams. The cover

plates shall be welded to the radial beam members with continuous seal welds from above and below the plates.

G. The cover Manufacturer shall provide drawings and support to the installing Contractor that will assist in minimizing the overhead weld requirements during the cover erection. Circumferential joints between cover plates may be butt or lap welded. All joints and seams required for gastight construction shall be continuously welded and coated with a protective coating as specified in DIVISION 9 of these specifications.

H. The dome-shaped cover shall have a radius of 1.5 times the nominal tank diameter. The dome framework shall consist of arched radial beams held in position by a center compression ring and peripheral thrusting ring. A closed section shall be used for the thrust ring to ensure maximum torsional stiffness. The members that compose the structural frame shall aid during the cover erection and provide support and capacity to carry the load of the complete cover once the field welding is completed.

2.2 FIXED COVER

A. The cover shall be supported on the top of the tank wall and shall be designed to resolve horizontal thrust loads into a peripheral thrust ring. It shall be stable under all design load conditions, including localized static and dynamic loads.

B. A cover support and anchoring assembly shall be fabricated from structural tubes welded to and extending from the thrust ring in such a manner that the moment load is transmitted to the thrust ring only and not the cover side skirt. A support and anchoring assembly shall be provided at and aligned with each radial beam. Steel support and anchoring assemblies shall be designed to provide bearing surfaces of Teflon or Fluorogold or UHMW and 304 stainless steel to minimize the transferal of friction loads to the tank walls during periods of steel thermal expansion and contraction.

C. A vertical side skirt plate located at a nominal radial distance of 2 in from the wall and extending below the thrust ring to a point 6” below normal operating water level shall be provided to trap digester gas beneath the cover.

D. The side sheet sections shall consist of ¼ in or 6 mm (metric equivalent) plates with a horizontal shelf plate at the bottom to support a sealant in the annular space between the side skirt plate and tank wall. The annular space shall be sealed by the Contractor with caulking, seal, and fill materials. The Contractor shall submit the proposed sealing system for approval by the Engineer.

2.3 COVER APPURTENANCES

A. The cover shall be designed to include the following appurtenances. Where applicable (for flanges of pipes/ports/nozzles up to 24" diameter), appurtenance flange bolt patterns shall match the bolt patterns of ANSI B16.5 Class 150 flanges:

1. One (1) 102 in minimum diameter gastight center compression ring with cover plate, neoprene gasket, and Type 304/316 stainless steel flange bolts and hardware.
2. Two (2) 36 in diameter manhole nozzles with Type 304 stainless steel flange bolts, hardware, and neoprene gaskets. The manhole covers shall meet the requirements of and be supplied as specified in Section 437600, Digester Gas Safety Equipment.
3. One (1) 42 in diameter manhole nozzle with Type 304 stainless steel flange bolts, hardware, and neoprene gasket. The manhole covers shall meet the requirements of and be supplied as specified in Section 437600, Digester Gas Safety Equipment.
4. One (1) 6 in diameter flanged nozzle for the gas safety equipment (flame arrestor and emergency pressure relief/vacuum breaker), Type 304 stainless steel flange bolts and hardware, and neoprene gasket. The gas safety equipment shall meet the requirements of and be supplied as specified in Section 437600, Digester Gas Safety Equipment.
5. Two (2) 8 in diameter sample tubes, extending below minimum operational liquid level; Type 304 stainless steel flange bolts and hardware; and neoprene gasket. The sample tube nozzle cover shall meet the requirements of and be supplied as specified in Section 437600, Digester Gas Safety Equipment.

PART 3 - EXECUTION

3.1 ANCHOR/ ASSEMBLY BOLTS

A. Any assembly/erection bolts and erection tabs shall be removed and the cover elements ground smooth.

B. Epoxy anchors, constructed of Type 304/316 stainless steel threaded rod with necessary hex nuts and washers, shall be provided to secure the cover to the concrete tank. Use HILTI Epoxy or equal. Follow epoxy manufacturer installation requirements.

3.2 FABRICATED ASSEMBLIES

A. Structural steel sections and plates required to form the cover shall be fabricated and shipped in sub-assemblies as large as practical with the unassembled members fabricated for assembly by field welding. To prevent corrosion, no bolted structural connections will be permitted in the interior of the cover. The cover plates shall be continuously welded to the beams to form a continuously sealed dome structure.

3.3 FINISHES

A. Steel plates, structural shapes and fabricated assemblies shall be shipped unpainted, for field painting by Contractor. After erection, welding, testing and final inspection of erection by Manufacturer's representative, the cover shall be painted as directed in DIVISION 9 of these specifications.

3.4 TESTING

A. After field erection is complete, the Contractor shall test the cover for gas tight construction by filling the tank with water and trapping air under the cover plates. All welded seams and appurtenances shall be checked for leaks by means of a soap suds solution. The air pressure underneath the dome during the test shall be not less than 14 in W.C.

B. Care shall be taken that all welds are carefully cleaned with a wire brush before the soap solution is applied. Any leaks shall be mechanically removed to sound base metal and then re-welded in accordance with American Welding Society D1.1 "Structural Welding Code - Steel" and re-tested.

END OF SECTION

SECTION 467627 – SLUDGE DEWATERING INCLINED SCREW PRESS

PART 1 GENERAL

1.1 SCOPE

A. The contractor shall furnish and install one (1) sludge dewatering screw press(es) as indicated on the drawings. Each screw press shall be manufactured from AISI 304L stainless steel shapes. Fabrication and assembly shall be in conformance with these specifications and drawings.

B. Each dewatering system shall include a screw press, polymer mixing device, polymer dosing system, drive motors, gear reducers, support legs, anchor bolts, piping and wiring, controls, and all accessories and appurtenances specified or otherwise required for a complete and properly operating installation.

C. The contractor shall coordinate all details of the equipment with other related parts of the work. He shall verify that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alterations required to accommodate equipment differing in dimensions, weight, or other characteristics from these specifications and drawings.

D. The contractor shall install the equipment according to instructions and recommendations of the equipment manufacturer.

E. The main power supply is 480 V, 60 Hz, 3-phase. The power supply for the air compressor shall be 120 V, 60 Hz, 1-phase.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM) Publications:

1. Section A322: Carbon and Alloy Steel Bar Specifications.
2. Section A507-10: Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold Rolled

B. ISO 281:2007 Calculation Method for Fatigue Life for Roller Bearings.

C. American Institute of Steel Construction (AISC) Publications

D. American Welding Society (AWS), European Welding Federation (EWF), and International Institute of Welding (IIW) Publications

E. American Structures Painting Council (ASPC) Publications

F. International Organization for Standardization (ISO) Publications.

1.3 SUBMITTALS

The manufacturer will provide an electronic submittal for review by the engineer in accordance with Section 01300.

A. Product Data: Include the following:

1. Descriptive literature, brochures, catalogs, cut-sheets and supplementary material to define the equipment.
2. Motor characteristics and performance information.
3. Gear reducer data including service factor, efficiency, torque rating, and materials.
4. Parts list including a list of recommended spare parts.

B. Shop Drawings: Include the following:

1. Manufacturer's installation drawings.
2. Wiring and schematic diagrams.

C. Operations and maintenance manual.

D. Detailed mechanical and electrical installation instructions and procedures.

E. Equipment weights and lifting points.

F. Recommendations for short and long-term storage.

G. A copy of the manufacturer's warranty.

H. A copy of documents proving certification of the Manufacturer's Quality Management System according to ISO 9001 and Environmental Protection Management System according to ISO 14001.

I. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

1.4 QUALITY ASSURANCE

A. To ensure quality, conformance, reliability, and environmental practices with regard to the manufacturing and production of the machinery described in this section, the equipment manufacturer shall meet the requirements listed in this section.

B. Manufacturer shall have established an ISO 9001 certified quality management system. Manufacturers without an ISO 9001 certified quality management program must provide complete documentation of their existing quality management system with supplemental information clarifying why areas do not meet ISO 9001 standards. Meeting national quality management standards alone shall not be considered an acceptable substitute because ISO standards exceed national quality management standards.

C. Manufacturer shall have established an ISO 14001 certified environmental protection management system. Manufacturers without an ISO 14001 certified environmental protection management system must provide complete documentation of their existing environmental protection

management system with supplemental information clarifying why areas do not meet ISO 14001 standards. Meeting national or local environmental protection management standards alone shall not be considered an acceptable substitute because ISO standards exceed national and local environmental protection management standards.

D. All stainless steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid (pickling bath) to remove any residues that may be present on the material because of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer, which is critical to the long life of the stainless steel.

E. No stainless steel components may be fabricated or assembled in a factory where carbon steel products are fabricated, in order to prevent contamination by rust.

F. The manufacturer shall have a minimum of twenty (20) years' experience producing dewatering screw presses and upon request will submit to the engineer documentation of fifteen (15) installations similar or larger than specified herein, that have been in operation for at least five (5) years.

G. All welding is performed in accordance with American Welding Society (AWS), European Welding Federation (EWF), International Institute of Welding (IIW), or equivalent.

H. Manufacturer shall provide screw press, motors, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

I. Manufacturer shall provide services by a factory-trained service technician, specifically trained on the type of equipment specified. Service technician requirements include, but are not limited to the following:

    1. Manufacturer shall have a minimum of ten (10) service technicians based in the United States for field service of the equipment. Manufacturer shall have multiple service locations with a minimum of one dedicated service location for both the eastern and western regions of the US.
    2. Service technician shall be present during initial energizing of equipment to determine directional testing.
    3. Service technician shall inspect and verify location of anchor bolts, placement, leveling, alignment and field erection of equipment, as well as control panel operation and electrical connections.
    4. Service technician shall provide classroom and/or field training on the operation and maintenance of the equipment to operator personnel.
    5. Manufacturer shall state field service rates for a service technician to owner and contractor. In the event that the field service time required by this section should not be sufficient to properly place the equipment into operation, additional time shall be purchased by

contractor to correct deficiencies in installation, equipment, or material without additional cost to owner.

J. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or installation, defective workmanship or materials, and breakage or other failure. Materials shall be suitable for service conditions.

K. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service prior to delivery, except as required by testing.

L. Each major component of equipment shall have the manufacturer's name, address and product identification on a nameplate securely affixed to the equipment.

1.5 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT

A. Equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

B. Contractor shall be responsible for unloading and shall have equipment on-site at the time of delivery permitting proper hoisting of the equipment.

1.6 PRE-SUBMITTAL OF ALTERNATE EQUIPMENT

Manufacturers of alternative equipment shall submit a pre-approval package to the engineer at least two (2) weeks prior to bid date. Alternative manufacturers shall submit the following information and supporting documentation:

A. A complete set of drawings, specifications, catalog cut sheets, and detailed descriptive material. Drawings shall show all relevant details of the unit. This information shall identify all technical and performance requirements stipulated on the drawings and in the specification. If the proposed equipment does not meet these specifications, any deviation from the specification must be expressly noted. All deviations shall be listed on a single document.

B. Detailed installation drawings illustrating how the proposed screw press will be installed. The drawings shall include plan, elevation, and sectional views of the installation. Drawings shall include details of the injection ring, mixing valve, flocculation reactor, and details of the anchor bolt locations.

C. Structural calculations by a Professional Engineer either confirming the existing structural design is sufficient for the alternate equipment or detailing any changes required for the building design to use the alternate equipment.

D. Motor characteristics and performance information. Vendor data shall be furnished to confirm the torque and thrust rating of the drives.

E. Complete reference list of all installations of same and similar equipment including contact names and phone numbers, showing at least 20 municipal installations of the same size as the alternate equipment located in the United States.

F. Complete bill of materials for all equipment, showing dimensions and materials of construction of all components.

G. Certification by the manufacturer that all stainless steel equipment will be manufactured in a stainless steel only factory.

H. Certification that the entire equipment will be passivated by submersion in an acid bath as specified in chapter 2.03.

I. A copy of documents proving certification of the Manufacturer's Quality Management System according to ISO 9001. Manufacturers without an ISO 9001 certified quality management program must provide complete documentation of their existing quality management system with supplemental information clarifying why areas do not meet ISO 9001 standards. Meeting national quality management standards alone shall not be considered an acceptable substitute because ISO standards exceed national quality management standards.

J. A copy of documents proving certification of the Environmental Protection Management System according to ISO 14001. Manufacturers without an ISO 14001 certified environmental protection management system must provide complete documentation of their existing environmental protection management system with supplemental information clarifying why areas do not meet ISO 14001 standards. Meeting national or local environmental protection management standards alone shall not be considered an acceptable substitute because ISO standards exceed national and local environmental protection management standards.

K. Details of the control and instrumentation system including wiring diagrams. A Professional Engineer shall note any required changes to the project electrical drawings.

L. Information on equipment field erection requirements including total weight of assembled components and weight of each sub assembly.

M. List of recommended spare parts and current cost of each spare part.

N. A maintenance schedule showing the required maintenance, frequency of maintenance, lubricants and other items required at each regular preventative maintenance period, including all ancillary equipment provided.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. HUBER Sludge Dewatering System Model Q-Press 800.2 from Huber Technology, Inc.

B. Liquid polymer blending system: by Velodyne, or UGSI

C. Pre-approved alternate manufacturer

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Sludge Characteristics: Sludge to be dewatered shall be well-mixed and well blended having the following characteristics:

Parameter		Value	Units
Sludge Type		Anaerobically Digested Blended Sludge	
Digestion Process		Anaerobic Digestion	
Solids Concentration		1.7	%
Volatile Solids		<55	%
pH		6.8 - 7.2	SU
Temperature		85	°F
Alkalinity		≥ 1,000	mg/L as $CaCO_3$
Total Dissolved Solids		≤ 1600	mg/L
Phosphate		≤ 25	mg/L
Chloride		≤ 400	mg/L
Percentage primary sludge:		90%	% by weight

B. Performance Requirements: Each dewatering screw press shall be capable of dewatering the above specified municipal wastewater sludge to meet the performance requirements outlined below:

Requirement	Value	Units
Hydraulic Loading Rate	59	gpm at 1.7% feed solids
Solids Loading Rate	500	lb/hr at 1.7% feed solids
Cake Solids	30	%
Capture Rate	95	%
Polymer Dose	<30	lb active polymer substance per dry ton of sludge solids fed

C. The sludge dewatering plant consists of the following major parts:

1. Screw Press including support legs
2. Polymer Injection Ring and Mixing Valve
3. Polymer Dosing System
4. Control Panel

D. All parts of the dewatering press shall be designed and appropriate for the service specified and indicated and for continuous operation.

E. Sufficient room for inspection, maintenance, repair and adjustment shall be provided. Contractor shall provide hoisting equipment to facilitate installation and maintenance work.

F. The physical layout shown on the drawings is based on the Huber Q-Press 800.2. If equipment by another manufacturer is to be supplied, contractor shall include in the bid all necessary modifications to the piping, electrical, structural, and mechanical layouts to accommodate the equipment proposed. Also if equipment by another manufacturer is to be supplied the manufacturer must meet the requirements of section 1.06. Contractor shall pay engineer in responsible charge for all modifications of drawings.

G. All parts shall be designed and manufactured to handle the forces that may be exerted on the screw press during fabrication, shipping, erection, and proper operation according to the O&M manual.

H. All components shall be so arranged that they can be serviced from the operating floor.

I. All components shall be balanced so that jamming at any point will not result in structural failure, but will cause the drive motor to stall. All components, including the gear reducer, shall be designed to withstand, without damage or permanent distortion, the full stalling torque of the drive motor.

J. Screw presses shall be capable of automated startup from empty. Automatic startup shall not require any operator labor in order to make cake solids.

2.3 SLUDGE DEWATERING PRESS DESIGN SPECIFICATIONS

A. MATERIALS

1. Sludge dewatering press shall be manufactured from AISI 316L stainless steel shapes (rods, angles, and channels), pipes, and sheets. In particular, wedge wire basket, screw, shaft, support legs, fasteners and anchor bolts shall be made of this material. Presses with carbon steel components shall not be acceptable because of corrosive wastewater environments.

2. Press access covers shall be either stainless steel or a composite of acrylonitrile butadiene styrene (ABS) and poly(methyl methacrylate) (PMMA). Materials other than stainless steel shall be acceptable if the material meets the following requirements:

   a. Is not a structural load-bearing component.
   b. Is equal to or exceeds stainless steel's resistance to wastewater environment chemicals.
   c. Is resistant to heat degradation up to 185°F (85°C).
   d. Is equal to or exceeds stainless steel's resistance to UV degradation.
   e. Is resilient to impact

3. Wipers for helical screw flights shall be of wear resistant polyurethane (PU) material. Wipers must have a basket contact width of at least .315 in (8 mm) to provide sufficient basket cleaning. The wiper is held in place by stainless steel clamps and set screws which can be easily removed. The wiper shall have a self-contained a dampening mechanism to maintain constant contact with the basket while limiting wear. Wiper self-contained dampening mechanism shall compensate for up to 4mm of radial wiper wear. Equipment using brushes or wipers without this functionality shall provide service trips and replacement parts for the first two (2) brush or wiper replacements to account for additional maintenance time. Equipment without wipers or brushes shall provide four (4) replacement baskets and augers to account for additional equipment wear. Equipment with moving and fixed ring systems shall provide service trips and replacement parts for the first four (4) replacement intervals to account for both the additional maintenance time and additional equipment wear.

B. DESIGN

1. The screw press shall be installed inclined (at 10º). Horizontal units shall provide a diverter chute to prevent wet material from discharging into the downstream process during startup.

2. Dewatering of the sludge takes place in a basket, which consists of three sections of wedge wire baskets. Basket openings shall vary in each of the three sections, from wider openings to tighter openings, to facilitate optimum release of water from the sludge. The overall basket length shall be 157.5 in (4,000 mm). The basket diameter shall be 31.5 in (800 mm). Baskets with constant basket opening sizes must provide a minimum basket length of 236 in (6,000 mm) to facilitate additional detention time in the unit for water release.

3. The screw press support legs shall be capable of field adjustment for ease of installation.

4. The screw press shall be completely enclosed to prevent odor emission. The whole dewatering section and basket area shall be easily accessible through an inspection lids, which are mounted via hinges on the side of the machine.

5. The wedge wire basket where the wet sludge enters the basket shall provide a minimum free surface area of 18.2% of the active wedge wire surface area to facilitate free water

drainage. Flanges and reinforcement bars, or supporting structures around the basket blocking the drainage of water shall be deducted from the active surface area. Baskets without this minimum free surface area must provide additional length of basket until they achieve this minimum free surface area.

6. Each section of the wedge wire basket shall be split in half along the length of the basket to allow for easy separation of the basket into halves for servicing of the wiper. The basket shall be fastened together using bolt fasteners made of stainless steel. The screw press shall be provided with alignment pins for ease of basket alignment during reassembly. The bottom half of the wedge wire basket shall remain inside of the machine during servicing of the wiper for ease of maintenance. Designs which require the bottom half of the basket to be removed from the machine for servicing the wiper will not be accepted because of additional service requirements.

7. The screw press shall be completely enclosed to prevent odor emission. The whole dewatering section and basket area shall be easily accessible through an inspection panels, which are mounted via hinges on the sides and quick release latches on the top of the machine.

8. A screw shall be installed inside of the screen basket. The screw transports the sludge from the inlet to the discharge area at the end of the pressure zone. Its shaft diameter shall be conical towards the discharge section of the machine. The flights of the helical screw shall be provided with a PU wiper to clean the wedge wire screen from the inside.

9. The screw shall be shafted and shall be made of stainless steel. A shaft-less screw is not acceptable because of the pressure and torque involved with dewatering. A bearing shall support the feed end of the screw shaft. Wear strips are not acceptable because of the frequent requirement for service.

10. A screw drive shall be provided at the discharge side of the press. The nominal motor power shall be 5.0 hp. The motor speed shall be controlled with a Variable Frequency Drive (VFD). The drive unit shall be directly coupled to the screw shaft through a planetary gearbox.

11. A pressure sensor shall be installed at the inlet housing of the screw press. The pressure sensor provides a signal which is used to control the speed of the auger. The pressure in the inlet box shall automatically adjust the speed of the screw via the control system and the range for the pressure shall be adjustable at the HMI. Designs which do not control the screw speed based on the inlet pressure are not acceptable because they require frequent operator attention.

12. The cleaning of the wedge wire screen from the outside shall be performed by a rotating spray bar washing system utilizing a single drive (drive: 0.25 hp, 460 V, 3 phase) made of stainless steel piping and PVDF spray nozzles. The spray wash system shall be split into four sections, upper feed, lower feed, upper discharge, and lower discharge, to cover the entire area of the basket by rotating around the circumference of the basket. Its spraying shall cover the entire area of the screen and also cover the interior of the screw press housing. In total four solenoid valves control the flow to each section of the spray bar washing system. The spray bar washing sections shall have the ability to operate independently. Designs which do not rotate around the circumference of the basket over the entire length of the basket will not be accepted because they fail to clean the entire basket.

13. To optimize wash water consumption, the spray bar system shall have the ability to perform a quick wash of only the lower basket and/or an extended wash of the entire

basket. Designs which do not have the quick wash ability shall not be accepted because of additional water consumption. Contractor shall provide water supply piping to the manifold of the spray system that shall have a 1-¼ inch female threaded connection. The system shall include two (2) proximity switches to prevent over travel of the spray bar system.

14. Spray water supply shall be designed for a minimum flow of 40 gpm (can be filtered non-potable water, allowed particle size 800 microns at maximum 200 ppm) at a minimum pressure of 70 psig. Water pressure at each nozzle of the spray bar shall be a minimum of 70 psig. Average spray water consumption shall not exceed 101 Gallons at 70 psig per wash cycle. Spray washing systems that operate at pressures less than 70 psig shall provide any necessary basket cleaning services at the owner's request for the first 10 years of operation to account for insufficient cleaning of the basket.
15. A pneumatically actuated cone that serves for adjusting the pressure in the pressure zone shall be provided at the discharge end of the screening basket. The pressurized air supply shall be provided by the contractor.
16. The pneumatically actuated cone is controlled by a 5-2-way solenoid valve. The solenoid directs the pressurized air to the ports which engage or disengage the cone at the discharge of the screw press. The control valve shall be installed in a local control station which also houses the pressure control valve and the pressure switch. The switch monitors the availability of pressurized air. If the supply of pressurized air is interrupted, the switch shall send a signal to the PLC and an alarm message will be generated.
17. Sludge cake shall be automatically discharged through a rectangular sludge discharge opening. The discharge height shall be minimum 39 in above floor level. Designs with standard discharge height lower than this minimum level must include provisions to interface properly with downstream equipment and a platform to allow proper service access to the equipment.
18. Screw press shall not exceed 10,500 lb operational weight.
19. Contractor shall provide a 6 in diameter drain line for the filtrate and connect it to the bottom drain connection of the screw press. The contractor shall also provide a 1.5 in flush connection with manual ball valve for the drain connection.

2.4 INTERNAL PIPING

A. Contractor shall provide and shall install a sludge feed pump. The sludge feed pump shall be of the progressive cavity type. The pump shall be controlled through a variable frequency controller (VFD) which is accepting a pacing signal from the screw press control panel, supplied by the manufacturer of the screw press.

B. Contractor shall provide sludge feed pipe from the sludge feed pump (with VFD) through a magnetic-inductive flow meter through a motorized inline polymer mixing device.

C. Polymer mixing device shall be supplied by the screw press manufacturer.

D. Pipe flocculator shall be supplied by the contractor and shall provide a minimum retention time of 60 seconds at design flow for the polymer and sludge mixture.

E. The design of the flocculation pipe reactor shall be approved by the screw press manufacturer.

F. The size of the piping needs to take into account: maximum capacity, loading rate, minimum velocity in piping to avoid sedimentation and conditions that do not negatively affect the flocculation process.

2.5 DRIVES

A. The press screw shall be driven by a shaft mounted gearbox and motor assembly. The gearbox shall be bolted to a machined flange welded to the upper end of the press.

B. The gearbox shall be driven by a motor with the following characteristics:

1. 5.0 hp
2. VFD sized for 3-phase, 60 Hz, 460 V, inverter duty
3. 0-2100 rpm
4. Continuous Duty
5. Permanent magnet motor
6. 40°C environmental temperature
7. Insulation Class F
8. Motor efficiency class IE4
9. Non-hazardous environment

C. The gearbox shall have the following outputs:

1. 30,000 Nm output torque
2. 0-1.1 rpm output speed

D. Chain drives, belt drives, hydraulic drives or a separate upper bearing for the transport screw will not be acceptable for this project.

2.6 AIR COMPRESSOR

A. Provide one (1) portable air compressor as manufactured by Speedaire, model #52YM09 or equivalent.

B. Air compressor shall use an induction type motor rated for 2.0 Hp, 120 V, 60 Hz, 15 Amps.

C. Shall have a NPT outlet of 1/4 in.

D. Tank shall be minimum 15 gallons.

2.7 POLYMER DOSING SYSTEM FOR LIQUID POLYMER

A. System shall be designed for the preparation, aging and dosing of up to 20 GPM of polymer solution having an active polymer concentration between 0.05 and 0.25 % for use with polymer injection ring

and mixing valve, or 0.03% with motorized inline mixer. The actual size of the polymer system depends on the specified type of sludge, maximum capacity and polymer consumption.

B. The polymer station shall be self-contained with pumps, piping, fittings, and accessories, and shall be factory assembled and tested to eliminate field assembly work and therefore to minimize installation and start up time. The frame shall be 304 stainless steel and the piping SCH.80 PVC.

C. A polymer mixing chamber shall be provided. A high energy, multi zoned, hydro-mechanical mixing device shall be provided. The mixing chamber shall have a translucent front cover.

D. The hydro mechanical impeller shall be designed to produce variable intensity, back flow mixing action to optimize polymer performance without damaging polymer molecular structure.

E. The motors shall be 0.5hp, 1750rpm, 90 V, 60Hz, wash down duty with keyless shaft and left hand impeller mounting screw.

F. Materials: Impeller - PVC; body of mixing device – PVC; cover – clear Lexan; fastener – 316 SS; seals – Viton; pressure rating – maximum 100 PSI.

G. Contractor shall provide a drinking water connection for the dilution of the polymer in the polymer tank. The water piping to the polymer blend system shall include a minimum 1 in inlet (NPT female), an UL listed solenoid valve (rated IP65), and a flow meter with a rate adjusting valve and low pressure alarm switch.

H. A neat polymer metering pump with hose connector shall be provided and connected through a 1/2 in barbed hose to the polymer mixing device. The neat polymer pump shall be a progressive cavity type pump.

I. Control Panel: NEMA 4X FRP enclosure, 120 VAC, 60 Hz, 1 PH service.

1. Operator interface – discrete selector switch (system ON/OFF/REMOTE); mechanical mixer speed adjust potentiometer; stroke length / stroke speed adjustment at metering pump
2. Status / Alarm indicators: system running indication; LCD display of metering pump rate (on metering pump); low pressure switch alarm
3. Inputs: remote start / stop (discrete dry contact); pacing signal from main control panel (4-20mA)
4. Outputs: system running (discrete dry contact); remote mode (discrete dry contact); low pressure alarm (discrete dry contact) ; low flow alarm (discrete dry contact)

J. The pressure side of the polymer system shall be connected through a minimum 1 in diameter PVC pipeline to the polymer injection ring.

K. The injection ring is the place where the polymer is added to the sludge. A mixing valve with adjustable weight follows to ensure optimum mixing conditions and creating the right size and strength of flocks. The retention time between the mixing valve and the dewatering machine shall be a minimum of 60 seconds at maximum flow.

L. Details of the polymer system: see Section 11

2.8 CONTROLS AND INSTRUMENTATION

A. All electrical and control equipment shall meet the requirements of Division 26 and Division 40

B. The entire control system shall be provided by the Manufacturer of the Screw Press.

C. The contractor shall provide wiring between all system components as required.

D. The contractor shall provide separate power supplies as followed:

1. 460 V, 60 Hz, 3 phase power supply to the main control panel
2. 120 V, 60 Hz, single phase power supply to the air compressor.
3. 120 V, 60 Hz, single phase power supply to the polymer dosing system panel

E. The dewatering system shall be full-automatic and shall include the following:

1. Main control panel for screw press
2. Magnetic-inductive flow meter for thin sludge feed
3. Automatic control for the pneumatic pressure cone

F. A 460-V main control panel shall be provided in a NEMA 4X Stainless Steel Enclosure. The enclosure shall be suitable for wall mounting in climate controlled room, shall have hinged covers which swing horizontally and shall be held closed with 3-Point Latch , and shall include the following:

1. Main power disconnect switch (pad-lockable)
2. Control power transformer
3. Surge arrester
4. Door Mounted Operators:
   a. Press HOA
   b. Press FOR (Spring Return from Reverse to Off)
   c. Wash Water SOV HOA
   d. System Reset
   e. E-Stop
5. 5. Door Mounted Status and Warning Lights for the following:
   a. Power on
   b. Dewatering system in operation
   c. System Disturbance
   d. Lights to be incandescent type, 30.5mm from Allen-Bradley or equal

6. 7.5 hp Schneider VFD, with Ethernet, shall be provided to control the screw press main drive. VFD shall meet the requirements of section 29 29 23 Variable Frequency Motor Controllers
7. 0.25 hp reversing motor starter including over-current and over-heat protection for the wash water spray drive. Motor starter shall be NEMA rated and shall be minimum NEMA size 0 motor starter
8. Programmable logic controller (PLC) Modicon M340 with on-board Ethernet meeting the requirements of specification section 40 94 43.
9. Operator Interface (OIU), Magellis, 6" with color touch screen. OIU shall have Ethernet and be protected with hinged window. Shall meet the requirements of specification section 40 94 33
10. Unmanaged Ethernet switch, 5-Port Phoenix or equal
11. The OIU shall have the capability to work as a data logger. The data logger shall document all important process parameter but not limited to the following list:
    a. Operation mode: OFF, dewatering, back wash, shutdown
    b. Drive operation: forward, reverse
    c. Sludge flow (GPM)
    d. Screw Speed
    e. Polymer pacing signal
    f. Pressure screw press inlet
    g. Press Motor amperage draw
    h. Set points: feed solids, polymer consumption, solid loading
12. The OIU shall provide maintenance reminder alarms for mechanical components which require replacement over-time. The OIU shall have a maintenance summary screen that displays the remaining hours of runtime until each mechanical component is recommended to be replaced. The OIU should produce an alarm banner for the specific component that needs replacement once the system has operated for the amount of hours the equipment manufacturer recommends. The maintenance summary screen shall also include the option to reset the alarm banner once the component has been replaced. Manufacturers not providing this functionality shall provide service trips every two years for maintenance operations.
13. Text messages displayed on touch screen:
    a. Over-current indications
    b. Spray bar washing system on
    c. Polymer dosing station status
    d. Running time meter for screw press and spray drive
14. Door mounted nametags shall be provided for the name of the control panel and all disconnects, switches, lights, and meters.
15. Terminal connections for interfacing with remote systems, shall include the following:
    a. Remote Polymer Injection System:
        1) Inputs to Dewatering Control Panel:
            a) Dry 120VAC Rated, 2 amp Minimum
               Polymer System In Remote
               Polymer System Running
               Polymer System Common Fault
        2) Outputs from Dewatering Control Panel:

a) Dry 120VAC Rated, 2 amp Minimum
Polymer System Call to Run

b) 4 – 20 mA Analog Output
Polymer Pacing Signal

b. SCADA Status:

1) Inputs to Dewatering Control Panel:

a) Dry 120VAC Rated, 2 amp Minimum
Remote Dewatering System Start Command

2) Outputs from Dewatering Control Panel:

a) Dry 120VAC Rated, 2 amp Minimum
Press Running
Press Fault
Dewatering Mode
System Disturbance

PART 3 EXECUTION

3.1 INSTALLATION, START-UP AND OPERATOR TRAINING

A. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify engineer of significant deviations.

B. Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply anchor bolts for the equipment. Contractors shall install the anchor bolts in accordance with the manufacturer's recommendations.

C. After installation, touch-up paint shall be applied to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting. Contractor shall passivate all field welds.

D. Supplier shall furnish the services of a factory-trained service technician for two (2) trips including a total of eight (8) workdays to inspect the installation, observe start up, and provide operator training.

1. Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the service technician present.
2. The service technician shall make all necessary adjustments and settings to the controls.
3. The service technician shall demonstrate proper and sequential operation of the dewatering system. The dewatering system shall be able to operate fully automatically.

3.2 WARRANTY

A. The manufacturer will warrant against any defects in material or workmanship to the screw press and framework. This warranty will commence upon delivery of the products and will expire on the earlier to occur of one (1) year from initial operation of the product or 18 months from delivery thereof (the "Warranty Period").

END OF SECTION 467627

SECTION 467800 - SLUDGE SPIRAL HEAT EXCHANGERS

PART 1 GENERAL

1.1 SCOPE

A. This section specifies Sludge Spiral Heat Exchangers.

1.2 REFERENCES

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

1. ASME boiler and pressure vessel codes, Section VIII, rules for construction and testing of pressure vessels.
2. ASTM A516/A516M pressure vessel plates, carbon steel, for moderate and lower temperature service.

1.3 SUBMITTALS

A. Shop Drawings:

1. Make, model, and weight of each equipment assembly.
2. Identification of materials of construction.
3. Detailed structural, and mechanical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
4. Process data including flow rates, temperatures, pressure drop and surface area.
5. Factory finish system.

B. Quality Control Submittals:

1. Factory Hydro Test Report.
2. Certificate of Compliance with ASME Code Section VIII, Division 1.
3. Operation and maintenance manual.

1.3 SPARE PARTS

None

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Alfa Laval Spiral Heat Exchangers.

2.2 SYSTEM PERFORMANCE

A. Heat Transfer: 1.5MMBtu/hour. The following parameters provide intended fluid flow recirculation rates and anticipated temperature changes of each fluid through the heat exchanger. Supplier to confirm fluid flow rates, temperature changes, and pressure drops required to provide design heat transfer capacity.

B. Hot Side Fluid: Water

1. Flow: 205 gpm.
2. Temperature: 155 degrees F inlet. 145 degrees F outlet.
3. Operating Pressure: 8.6 psig.
4. Maximum Pressure Loss: 1.5 psi.

C. Cold Side Fluid: Sludge (3% - 5% Solids by Weight)

1. Flow: 300 gpm.
2. Temperature: 95 degrees F inlet. 105 degrees F outlet.
3. Operating Pressure: 11 psig.
4. Maximum Pressure Loss: 3 psi.

2.3 EQUIPMENT TAG NUMBER(S)

A. As required.

2.4 MATERIALS

A. Exchanger:

1. Material: Carbon steel construction with minimum nominal thickness of 0.25 inch for internal coil.
2. External spiral type with two concentric spiral channels for counter currently circulation of sludge and hot water. Tube-in-tube, plate and boiler/heat exchanger types are unacceptable.
3. Sludge channel provided with large inlet compartment offering tangential entry and a 4-inch cleanout for sludge pocket.
4. Sludge channels shall be a minimum of 1 inch high and free of any sharp bends, support pins or any other obstruction.
5. Hinged front covers fastened with a minimum of twenty ¾-inch zinc-plated hook-bolts and clamps to easily access sludge channel for cleaning.

B. Nozzles: ANSI B16.5, Class 150 flange, for all connections 3 inch and larger.

C. Gaskets: Full-face non-asbestos fiber sheet minimum 0.125-inch thick.

D. Connections: 2" NPT Back-flush connections on sludge side, and 1-inch coupling drain. Water side shall have couplings for drains at low point of each spiral channel.

2.5 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with ¼-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

2.6 FACTORY FINISHING

A. Sandblast in accordance to SSPC-SP-6. External carbon surfaces, except machined surfaces, or flanges painted with International Interlac 789 (single component modified alkyd primer/finish). 4.0 mil minimum finish coat in Alfa Laval blue.

2.7 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect equipment for required construction and intended function.

B. Hydrostatic testing shall be in accordance with ASME Section VIII, Division 1.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Mount heat exchanger level on concrete and grout bases.

C. Anchor Bolts: Shall be furnished and installed by installing contractor.

D. Pressure and temperature gauges (where required) shall be furnished and installed by the installing contractor.

3.2 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on the exchanger.

1. Alignment: Test complete assemblies for proper alignment and connection and leakage.

B. Performance Test:

1. Conduct on each exchanger.
2. Test for a continuous 30-minute period on sludge and hot water channels without malfunction or leakage.
3. After completion of installation, heat exchanger shall be field tested to ensure compliance with the performance requirements, as indicated.

3.3 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at site or classroom for minimum person-days listed below, travel time excluded:

1. 1 man-day for installation inspection and operator training. Certificate of Proper Installation shall be provided by manufacturer.

END OF SECTION 467800

APPENDIX A

SOUTH DAVIS SEWER DISTRICT

North Plant Upgrade Project

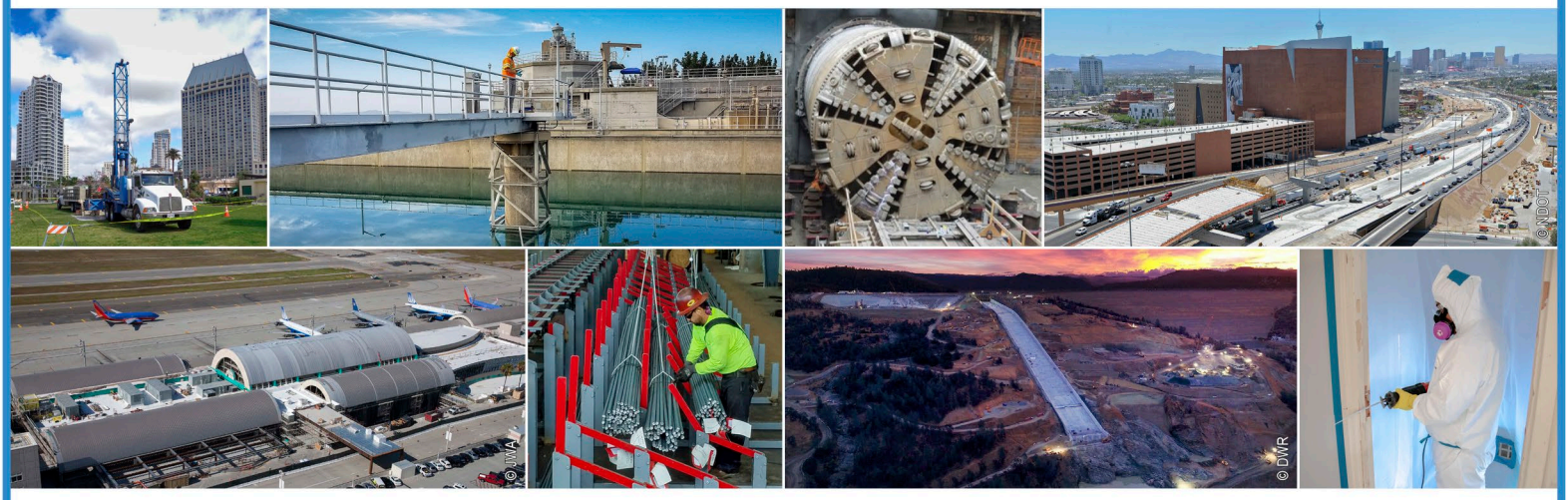
APPENDIX A

AQUA ENGINEERING

Geotechnical Evaluation
South Davis Sewer District
North Plant Additions
1800 West 1200 North
West Bountiful, Utah

South Davis Sewer District
1800 West, 1200 North | West Bountiful, Utah 84087

October 19, 2023 | Project No. 800272001



Geotechnical | Environmental | Construction Inspection & Testing | Forensic Engineering & Expert Witness

Geophysics | Engineering Geology | Laboratory Testing | Industrial Hygiene | Occupational Safety | Air Quality | GIS

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

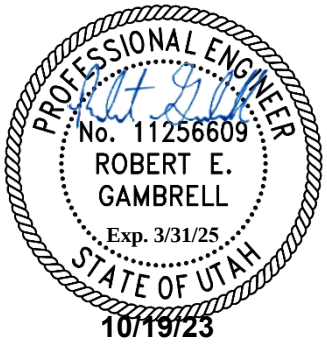
Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

35+ YEARS

Geotechnical Evaluation
South Davis Sewer District
North Plant Additions
1800 West 1200 North
West Bountiful, Utah

Mr. Matthew Myers, P.E.
South Davis Sewer District
1800 West, 1200 North | West Bountiful, Utah 84087

October 19, 2023 | Project No. 800272001



10/19/23

Robert E. Gambrell, PE
Senior Engineer

Eric D. Elison, PE
Principal Engineer

REG/EDE/kgg/cas

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1 INTRODUCTION

In accordance with your request, Ninyo & Moore has performed a geotechnical evaluation for the proposed South Davis Sewer District North Plant Additions project to be constructed at the existing wastewater treatment facility located at 1800 West 1200 North in West Bountiful, Utah. The approximate location of the site is indicated on Figure 1. The purposes of our geotechnical study were to evaluate subsurface soil conditions at the project site and to provide design and construction recommendations regarding geotechnical aspects of the project. This report presents the findings of our subsurface exploration, results of laboratory testing, conclusions regarding subsurface conditions at the project site, and geotechnical recommendations for design and construction of this project.

2 SCOPE OF SERVICES

The scope of our services included the following:

- Review of pertinent background information, including in-house geotechnical data, aerial photographs, published regional and local geologic maps, and soils data.
- Coordination and mobilization for subsurface exploration. Mark-out of existing utilities was conducted through Blue Stakes of Utah.
- Performance of a refraction microtremor (ReMi) survey to evaluate the shear wave velocity profile at the project site to a depth of approximately 100 feet.
- Drilling, logging, and sampling of nine exploratory borings to depths up to approximately 71.5 feet. The purpose of the soil borings was to evaluate the subsurface soil and groundwater conditions, including obtaining soil samples for laboratory testing.
- Performance of laboratory tests to evaluate the geotechnical characteristics of the subsurface soils, including in-place moisture content and density, gradation, Atterberg limits (plasticity), consolidation potential, shear strength, triaxial compression (UU), chemical (corrosivity) considerations, including pH, oxidation-reduction potential, electrical resistivity, water-soluble sodium content, water-soluble sulfate content, water-soluble chloride content, and total dissolved solids.
- Compilation and analysis of the field and laboratory data.
- Preparation of this report presenting our findings, conclusions, and recommendations.

3 PROJECT DESCRIPTION

The project will include design and construction of additional wastewater treatment facilities to the existing infrastructure of the South Davis Sewer District North Plant. The following table summarizes structure sizes and anticipated loads:

Table 1 – Anticipated Structures				
Structure	Footprint (ft^2)	Approximate Weight (kips)	Bearing Pressure (ksf)	Nearest Boring
Headworks	4,060	3,988	0.98	B-8
Chemical Mixing Box	1,100	1,117	1.02	B-9
Clarifier 4	4,418	3,584	0.81	B-11
Blower Building	8,166	2,000	0.24	B-6
MBBR Tank	9,126	13,674	1.50	B-10
Digester 3	5,027	11,427	2.27	B-4
Dewatering Building	3,901	1,805	0.46	B-3
Chemical Storage Building	1,296	1,000	0.77	B-7
Administration Building	6,000	2,219	1.2*	B-5

Note: *Allowable bearing capacity for conventional shallow foundations with settlement limited to less than 1 inch.

The proposed structures are anticipated to be of reinforced concrete, structural masonry, and/or wood-frame construction supported on conventional spread foundations (administration building) and mat foundations. Additional improvements may include an outflow pipeline, concrete flatwork, low-height retaining walls, asphalt concrete paved parking, and access areas. The project site and proposed structures are shown on Figure 2A and Figure 2B, respectively.

4 GENERAL SITE CONDITIONS

At the time of our field activities, the western portion of the project site was developed with the existing South Davis Sewer District North Plant, which included an administrative office, miscellaneous facility buildings, ponds/lagoons, and several storage/treatment tanks. The northeastern portion of the site was developed with an equipment storage yard containing excavators, water transport trucks, and other heavy equipment. Undeveloped land was observed in the central portion of the site, along with two single-family homes and an RV storage area. Crates of glass/ceramic tubes were observed on this undeveloped land along the eastern boundary of the existing treatment plant. The site is located on the eastern boundary of the West Bountiful city limits. Adjacent properties include undeveloped marshland of the Great Salt Lake to the north and west, Bountiful Lake to the northeast, North Shoreland Drive and Legacy Parkway to the east and south, and undeveloped land to the southwest. The topography at the site relatively flat with a total relief of less than 3 feet. Indications of underground utilities were observed at the site, including power, gas, sanitary sewer, storm water, communication, and water lines. Additional underground utilities may also be present at or near the site.

5 GEOLOGY

Based on our field observations, subsurface exploration, review of referenced geologic and soils data, the project site is underlain primarily by Upper Pleistocene to Holocene-age lacustrine, alluvial, marsh soil deposits (native soil) consisting primarily of clay, silt, and sand deposits. Ninyo & Moore's findings regarding the geologic setting, potential geologic hazards, ground motions, and liquefaction potential at the project site are provided in the following sections.

5.1 Geologic Setting

The project site is located in the Wasatch Front Region along the western base of the Wasatch Range. The Wasatch Front is located on the eastern edge of the Great Basin, which is made up of many naturally formed structural basins resulting from block faulting, which is a fundamental characteristic of the Basin and Range physiographic province.

The Wasatch Front Region extends in a north-south direction and generally drains toward the west through rivers and washes. The referenced geologic map titled *Geologic Map of the Farmington Quadrangle, Salt Lake and Davis Counties, Utah* (Lowe et al., 2018) indicates that the project area is underlain primarily by Upper Pleistocene to Holocene-age lacustrine, alluvial, and marsh deposits that are composed primarily of clays and silts with minor fine to medium-grained sand deposits from fluctuating levels of the Great Salt Lake.

5.2 Potential Geologic Hazards

Ninyo & Moore's geotechnical study included an evaluation of the possible presence of geologic hazards, such as faults and ground fissures, in the site area. This evaluation included visual observation of the site for indications of adverse geologic features and review of published geologic and soils maps, literature, and other data listed in the References section of this report. Referenced geologic data were also reviewed to evaluate seismic activity levels, and associated potential earthquake hazards, for faults in the site vicinity. The fault seismic activity levels were obtained/interpreted primarily from the referenced United States Geological Survey (USGS, 2023) data.

Based on our review of referenced data, no faults traverse the project site. Surficial disturbance associated with active faulting was not observed at the site during our field evaluation. Review of referenced geologic data indicates that the nearest active fault (i.e., a fault that has experienced ground surface rupture within the past 10,000 years) to the site is a fault in the Weber segment of the Wasatch fault zone. Table 2 lists the principal, known active faults that may affect the project site along with approximate fault-to-site distances and anticipated maximum moment magnitudes

(M_{max}). The approximate fault-to-site distances, M_{max} values, and activity levels were obtained using the referenced USGS web-based programs (USGS, 2014; USGS, 2023).

Table 2 – Principal Active Faults in Vicinity of Project Site

Fault Name	Approximate Distance From Project Site to Fault (miles)	Maximum Moment Magnitude (M_{max})
Wasatch Fault Zone, Weber Segment (Active)	3.2	7.1
Wasatch Fault Zone, Salt Lake Segment (Active)	3.8	7.1
West Valley Fault Zone, Taylorsville Segment (Active)	6.7	6.5
West Valley Fault Zone, Granger Segment (Active)	8.5	6.5
Great Salt Lake Fault Zone, Antelope Island Segment (Active)	14.3	6.9
Morgan Fault Zone, Central Segment (Active)	17.1	6.5

Review of the referenced geologic data does not indicate the presence of ground fissures at the project site and no ground fissures were observed during our field activities. Additionally, our review indicates that the site is not located in a *Surface Fault Rupture Hazard Special Study Zone* (UGS, 2008b).

5.3 Ground Motions

Using the Applied Technology Council (ATC) Hazard Tool (https://hazards.atcouncil.org), estimated maximum considered earthquake spectral response accelerations for short (0.2 second) and long (1.0 second) periods were obtained for the project site, which is located at approximately 40.9015 degrees north latitude and -111.9298 degrees west longitude. Based on the results of our field exploration and ReMi survey, American Society of Civil Engineers (ASCE) Standard 7-16 (ASCE, 2016), and a review of available geologic information, Seismic Site Class D is appropriate for the project site. The parameters presented in the following table are characteristic of the site for design purposes.

Table 3 – Seismic Design Criteria

Site Coefficients and Spectral Response Acceleration Parameters	Values
Site Class	D
Site Coefficient at 0.2-second Period, F_a	1
Site Coefficient at 1.0-second Period, F_v	1.804
Mapped Spectral Response Acceleration at 0.2-second Period, S_S	1.359g
Mapped Spectral Response Acceleration at 1.0-second Period, S_1	0.496g
Spectral Response Acceleration at 0.2-second Period Adjusted for Site Class, S_{MS}	1.359g

Table 3 – Seismic Design Criteria	
Site Coefficients and Spectral Response Acceleration Parameters	Values
Spectral Response Acceleration at 1.0-second Period Adjusted for Site Class, S_{M1}	0.895g
Design Spectral Response Acceleration at 0.2-second Period, S_{DS}	0.906g
Design Spectral Response Acceleration at 1.0-second Period, S_{D1}	0.597g
Site Amplification Factor, F_{PGA}	1.1
Peak Ground Acceleration, PGA	0.61g
Modified Peak Ground Acceleration, PGA_M	0.671g

5.4 Liquefaction Potential

Liquefaction is a phenomenon in which loose, saturated soils lose shear strength under short-term (dynamic) loading conditions. Ground shaking of sufficient duration results in the loss of grain-to-grain contact in potentially liquefiable soils due to a rapid increase in pore water pressure, causing the soil to behave as a fluid for a short period of time.

To be potentially liquefiable, a soil is typically cohesionless with a grain-size distribution generally consisting of sand and silt. It is generally loose to medium dense and has relatively high moisture content, which is typical near or below groundwater level. The potential for liquefaction decreases with increasing clay and gravel content, but increases as the ground acceleration and duration of shaking increase. Potentially liquefiable soils need to be subjected to sufficient magnitude and duration of ground shaking for liquefaction to occur.

An in-depth evaluation of the potential for liquefaction at the site was outside the scope of this geotechnical evaluation. Review of the referenced geologic data indicates that the project site is mapped in a zone with a high liquefaction potential. However, based on the fine-grained nature of the soils encountered, liquefaction is not a design concern.

6 FIELD EXPLORATION AND SUBSURFACE CONDITIONS

Ninyo & Moore's subsurface exploration at the project site was performed on May 9, 2023 through May 15, 2023, and June 11, 2023. This exploration consisted of drilling, logging, and sampling of nine exploratory test borings (B-3 through B-11) and two hand auger borings (HA-1 and HA-2). The test borings were drilled with a Marl M5 drill rig utilizing 8-inch diameter hollow-stem augers. The borings were drilled to depths up to approximately 71.5 feet. The soil consistency was evaluated with a portable dynamic cone penetrometer (DCP) in the hand auger borings. The purpose of the borings was to evaluate subsurface conditions at the project site and to collect soil samples for laboratory testing. The elevations of the borings based on Mean Sea Level (MSL) were estimated from Google Earth (Google Earth Website, 2023) data. Accordingly, the ground

elevations that are recorded on the boring logs in Appendix A should be considered approximate. The approximate locations of the borings are shown on Figures 2A and 2B.

Laboratory tests were performed on representative soil samples collected from the borings to evaluate the in-place moisture content and density, gradation, Atterberg limits (plasticity), consolidation potential, shear strength, triaxial compression (UU), chemical (corrosivity) considerations, including pH, oxidation-reduction potential, electrical resistivity, water-soluble sodium content, water-soluble sulfate content, water-soluble chloride content, and total dissolved solids. The results of the in-place moisture content and density tests are provided on the boring logs in Appendix A. The other laboratory test results and descriptions of testing procedures utilized are presented in Appendix B and Appendix C.

6.1 Asphalt Concrete Pavement and Aggregate Base

Borings B-3 and B-7 were drilled through asphalt concrete pavement approximately 2.5 and 5.5 inches thick. Aggregate base was generally encountered beneath the pavement approximately 6.5 and 9.5 inches thick. The aggregate base was comprised primarily of sand and gravel. The approximate thicknesses of the asphalt concrete and aggregate base at each boring location are provided in the table below.

Table 4 – Summary of Pavement and Aggregate Base Thickness

Boring	Asphalt Concrete Thickness (in.)	Aggregate Base Thickness (in.)
B-3	5.5	6.5
B-7	2.5	9.5

6.2 Subsurface Soil Encountered

Generalized descriptions of the subsurface soils encountered in the exploratory borings are provided in the following sections.

6.2.1 Topsoil

Topsoil, including highly organic soil with considerable amounts of roots, was encountered in the upper soils of Borings HA-1, B-6, and B-9 through B-11. These surficial soils were approximately 2 to 3 inches thick.

6.2.2 Fill Soil

Fill materials were encountered in our borings extending to depths up to approximately 5.5 feet below the ground surface. The encountered fill soils consisted primarily of firm to hard, lean clay; medium dense gravel with clay; and loose to dense sand with silt. The encountered fill materials were generally dry to moist. Existing fill materials should be considered undocumented fill and unsuitable for support of structures and improvements in their present condition. The term undocumented fill refers to fill placed without engineering control and documentation. Fill soils may be left in place where documentation can be provided showing that the soils were engineered.

6.2.3 Native Soil

Native soil was encountered below the fill to the total depths of our exploratory borings. The encountered native soil consisted primarily of significant layers of soft to hard, lean and fat clay with varying amounts of sand, and a few layers of loose to very dense sand with varying amounts of silt and clay, and loose to medium dense silt with varying amounts of sand. The encountered native soils were generally moist to wet.

6.3 Laboratory Testing

Laboratory tests were performed on representative samples of soil obtained from the exploratory borings. Results of these tests are summarized in the following table and presented in Appendix B and Appendix C.

Table 5 – Summary of Laboratory Test Results

Test Type	Test Results	Remarks
In-Place Moisture Content	6.8 to 37.8 percent	--
In-Place Dry Density	78.1 to 119.8 pcf	--
Atterberg Limits Liquid Limit Plastic Limit Plasticity Index	 31 to 39 15 to 17 16 to 24	 Low plasticity
Direct Shear Peak Cohesion Peak Friction Angle	 65 and 919 psf 22 and 36 degrees	 --
UU Triaxial Compression Shear Stress	 350 to 1348 psf	 --
pH	8.4 to 9.5	--
Oxidation-reduction Potential	295 to 385 mV	--
Electrical Resistivity	1.4 to 6.4 Ohm-m	Severe to very severe corrosion potential to normal grade steel.

Table 5 – Summary of Laboratory Test Results		
Test Type	**Test Results**	**Remarks**
Water-Soluble Sodium	871 to 3,980 mg/kg (ppm)	--
Water-Soluble Sulfate	68 to 237 mg/kg (ppm)	Sulfate Exposure Class S0 to S1 – Low to moderate corrosion potential to concrete.
Water-Soluble Chloride	34 to 2,940 mg/kg (ppm)	Low to very severe corrosion potential to normal grade steel.
Total Dissolved Solids (Solubility)	19,400 to 67,200 mg/kg (ppm)	High solubility potential.

6.4 Groundwater

Groundwater was encountered in our borings at depths of approximately 4 to 14 feet at the time of drilling. The following table presents a summary of stabilized groundwater depths measured approximately 24 to 72 hours after drilling.

Table 6 – Summary of Stabilized Groundwater Measurements		
Boring	**Measured Depth to Groundwater (feet)**	**Approximate Time Measurement Taken after Drilling (hours)**
B-3	8.5	24
B-7	4.0	48
B-9	3.7	96
B-12	2.3	48

Groundwater levels are influenced by seasonal factors, variations in ground surface topography, precipitation, water levels in nearby ponds/lagoons, irrigation practices, soil types, groundwater pumping, and other factors and are subject to fluctuations. Evaluation of factors associated with groundwater fluctuations was beyond the scope of this study.

6.5 Refraction Microtremor (ReMi) Survey

Ninyo & Moore performed a ReMi survey to obtain the shear wave velocity profile to a nominal depth of approximately 100 feet at the subject site to evaluate Seismic Site Class in general accordance with ASCE 7-16 (ASCE, 2016). The approximate location of the survey is indicated on Figure 2. Data was collected using a 24-Channel Geometrics Geode, exploration seismograph coupled with 24 vertical component 4.5 Hertz geophones spaced approximately 20 feet apart. Ambient noise (microtremors) was recorded for a total period length of 30 seconds. The average shear wave velocity for the upper 100 feet was 613 feet per second, which indicates a Seismic Site Class D. The one-dimensional shear wave velocity structure is provided in Appendix D.

7 FINDINGS AND CONCLUSIONS

Based on the findings of this study, it is our opinion that there are no known geotechnical or geologic conditions that would preclude construction of the proposed project, provided the recommendations presented herein are implemented and appropriate construction practices are followed. Geotechnical design and construction considerations for the proposed project include the following:

- **Settlement:** We encountered soft, compressible soil layers that are prone to consolidation settlement. Based on the conditions encountered in our borings and our evaluation of mat foundations with the provided loading, we anticipate that static settlement of foundations will generally range from less than 1 inch to 12 inches. Accordingly, settlement mitigation, such as surcharge loading, should be anticipated for some of the structures. Additional recommendations regarding settlement mitigation will be provided in an addendum to this report.

- **Existing Fill:** Fill material, which is considered undocumented/non-engineered, was encountered to depths up to approximately 5.5 feet in our exploratory excavations. Deeper areas of fill at the project site should be anticipated. Since undocumented/non-engineered fill is not suitable for support of proposed project improvements, this soil will need to be removed in areas of proposed structures and improvements. The existing fill may be left in-place if documentation can be provided indicating that the fill was “engineered.”

- **Groundwater:** Groundwater was encountered in our exploratory borings at depths ranging from approximately 2.3 to 14.0 feet. Shallow groundwater will be encountered during earthwork and excavation operations. Dewatering and subgrade stabilization should be anticipated.

- **Dewatering Induced Settlement:** Due to relatively high moisture contents (up to 37.8 percent based on our laboratory testing), shallow groundwater (as shallow as 2.3 feet deep), and saturated conditions encountered in the subgrade soil at the site, there is a significant risk of excessive settlement and damage to existing structures due to construction dewatering. Accordingly, dewatering should be limited, where possible. A rigorous program of settlement monitoring of existing structures should be performed if dewatering is utilized during construction.

- **Structural Fill and Backfill:** The findings of our study indicate that the soils encountered in our exploratory borings generally should be suitable for use as structural fill and backfill material for the project. The excavated on-site soils may be used as structural fill and backfill provided they comply with the recommendations presented in Section 8.2.3.

- **Topsoil:** Highly organic soil (topsoil) was encountered in the upper approximately 2 to 3 inches in some of our explorations. These upper soils are not appropriate for use as structural fill. Where encountered, topsoil will need to be removed from proposed structure and improvement areas.

- **Subgrade Support:** Structure foundations and other project improvements should be supported on medium dense to very dense native granular soils, on stiff to hard fine-grained native soils, or on a zone of adequately placed and compacted structural fill. Depending on proposed structure loading, some areas of the project site, as discussed in Section 8.5, will need surcharge loading or be supported on soils improved with rammed aggregate piers.

- **Subgrade Stabilization:** Groundwater was measured at depths as shallow as approximately 2.3 feet in our exploratory borings. In addition, based on our moisture content test results, relatively moist to wet conditions will be likely be encountered at relatively shallow depths during excavation and earthwork operations. Therefore, potentially unstable and pumping subgrade conditions should be anticipated during grading and in excavation bottoms. In addition, contractors for this project should anticipate that construction dewatering will be needed for the project to aid in stabilizing excavation walls and trench bottoms, and to aid in placement and compaction of structural fill and backfill.

- **Undermining:** There is a potential for damage to existing structures due to undermining and loss of lateral support for the structure's foundation during construction of adjacent footings for the nearby proposed structures. We strongly emphasize that the contractor for the project take adequate precautions during construction so that movement of the existing structures does not occur. Precautions may include placement of shoring, installation of sacrificial jacks, underpinning, and/or performance of soil removal adjacent to the foundation in sections up to several feet in length.

- **Seismic Parameters:** In accordance with ASCE 7-16, the seismic parameters provided in Table 3 are characteristic of the site and should be considered, where appropriate, in design of the proposed structures.

- **Liquefaction:** The project site is mapped in a zone with a high liquefaction potential. However, based on the primarily fine-grained nature of the encountered soils, liquefaction is not considered a design concern.

- **Geologic Hazards:** Review of published geologic data and our field observations do not indicate the presence of adverse on-site geologic hazards, such as faults and ground fissures, which may affect proposed site development.

- **Corrosion Potential:** Chemical test results indicate that the tested soils have a low to very severe corrosion potential to metal and concrete.

- **Underground Utilities:** Indications of several underground utilities were observed at the site during our field activities. Existing utilities at the site should be located and marked prior to earthwork operations, and they should be removed from proposed building and other site improvement areas or abandoned in-place.

8 RECOMMENDATIONS

The following sections provide geotechnical recommendations for design and construction of proposed project improvements.

8.1 Demolition and Construction Vibrations

The subject project will include demolition of existing structures and improvements. Although not encountered during our subsurface exploration, there may be buried concrete remnants, areas of deeper fills, or other features present below the ground surface. Remnants from the demolition activities should be removed from the site.

Demolition of the existing improvements should include rerouting, removal, or in-place abandonment of underground utilities. Utilities should be adequately capped or rerouted at the project perimeter in accordance with the requirements of the governing authorities and the recommendations of the geotechnical consultant at the time of demolition. Abandoned underground utility pipes under proposed building limits should be removed from the site, or, if the pipes are left in place, they should be filled with flowable fill, such as grout or controlled low strength material (CLSM). The contractor should take adequate precautions when grading the site to reduce the potential for damage to existing utilities that are to remain in service.

Construction and demolition activities will be in close proximity to adjacent structures and surrounding improvements. Vibrations created from demolition and construction operations may cause distress to adjacent utilities, structures, and improvements. Prior to the initiation of the demolition activities, we recommend performing a detailed pre-demolition survey of the adjacent buildings and other surface improvements. In addition, a vibration monitoring plan should be prepared and implemented during demolition and construction activities. The vibration monitoring plan should provide a description of planned scope of monitoring services, and should establish a schedule and protocol for the vibration monitoring services once the demolition and construction of the project begins. Ninyo & Moore may be retained to provide such services, upon request.

8.2 Earthwork

The following subsections provide recommendations for earthwork, including site grading, subgrade stabilization, structural fill and backfill, import soil, excavations and dewatering, and temporary excavations and shoring.

8.2.1 Site Grading

Prior to grading, areas of proposed structures and improvements should be cleared of any surface obstructions, pavement, debris, topsoil, vegetation, undocumented fill, and other deleterious material. Existing fill materials should be considered undocumented/non-engineered and unsuitable for support of structures and improvements in their present condition. The term undocumented fill refers to fill placed without engineering control and documentation. Such materials generated from clearing operations should be removed and disposed of in non-structural areas or at a legal landfill. Fill soils may be left in place where documentation can be provided showing that the soils were engineered. Findings of our study indicate that the soils encountered in our exploratory borings generally should be suitable for use as structural fill and backfill material for the project. Highly organic soil (topsoil) was encountered in the upper approximately 2 to 3 inches in some of our explorations. These

upper soils are not appropriate for use as structural fill. Where encountered, topsoil will need to be removed from proposed structure and improvement areas. Soils excavated in areas of proposed project improvements may be re-used as structural fill and backfill provided they conform to recommendations provided in Section 8.2.3.

After the removals described above have been made, the exposed native soils should be scarified to approximately 6 inches, moisture-conditioned to approximately optimum moisture content, and compacted to 90 percent or more relative compaction, as evaluated by ASTM International (ASTM) Standard D1557. The project's geotechnical consultant should observe excavation bottoms and areas to receive fill at the time of grading to assess the suitability of the exposed material and to evaluate if removals down to more competent soils are needed.

Surface preparations should extend 5 feet or more beyond the exterior edges of planned structure foundations and 2 feet or more beyond planned exterior concrete flatwork, pavement areas, and retaining/screen walls, or to a lateral distance that is equivalent to the depth of compacted structural fill, whichever is greater.

Based on the density/consistency of the existing native soils at the site, some shrinkage should be anticipated when these soils are excavated, processed, and compacted. For planning purposes, an estimated shrinkage factor of approximately 25 percent may be used for on-site soils encountered in the upper 5 feet.

8.2.2 Subgrade Stabilization

As previously indicated, high moisture content soils and relatively shallow groundwater levels were noted at the site during our field activities. Due to these moist to wet subgrade conditions, pumping subgrade should be anticipated during excavation and earthwork operations. Subgrade stabilization will be needed where pumping subgrade conditions are encountered. Pumping conditions may occur where excavations extend near to or below groundwater levels and where moisture content of in-situ soils is relatively high.

Stabilization methods should be provided by the grading contractor, as needed, and may include the use of a geogrid, such as Tensar TX160, or a woven geotextile fabric, such as Mirafi 600X, placed on unstable subgrade and overlain by 12 inches of crushed rock (Untreated Base Course). Pushing oversized angular rock, up to approximately 6 inches in nominal diameter, into exposed unstable subgrade soils may also be an appropriate stabilization alternative. The volume of rock needed will vary based upon factors including the moisture content of the native soil, soil type, depth to groundwater, and total affected

area. Placement of angular rock should continue until the area exhibits a relatively non-yielding behavior as observed or tested by the geotechnical consultant.

If conditions are observed that indicate additional stabilization efforts may be needed (e.g. excavations extending below groundwater), a combination of over-excavation, rock fill, and geogrid placement should be considered. Dewatering and use of relatively light or tracked earthwork equipment may also be needed. The geotechnical consultant/engineer during construction should evaluate proposed subgrade stabilization methods prior to their implementation.

8.2.3 Structural Fill and Backfill

The following sections include recommendations regarding soil suitability, placement, and compaction of structural fill and backfill.

8.2.3.1 Soil Suitability

Based on the findings of our subsurface evaluation and laboratory test results, the soils encountered during our exploration below the upper organic-rich soils should generally be suitable for use as structural fill and backfill material. The excavated on-site soils may be used as structural fill and backfill provided they comply with the recommendations presented in this section.

Structural fill and backfill soil should not contain organic matter, debris, other deleterious matter, or rocks or hard chunks larger than approximately 4 inches in nominal diameter. These soils should have a very low to low expansion potential (Expansion Index, EI, less than 50, as evaluated by ASTM D4829).

8.2.3.2 Placement and Compaction

Soils used as structural fill and backfill should be moisture-conditioned to approximately optimum moisture content and placed and compacted in uniform horizontal lifts to a relative compaction of 93 percent, as evaluated by the ASTM D1557. The optimal lift thickness of fill will depend on the type of soil and compaction equipment used, but should generally not exceed approximately 8 inches in loose thickness. Placement and compaction of structural fill should be performed in accordance with applicable building codes.

Earthwork operations should be observed and compaction of structural fill and backfill materials should be tested by the project's geotechnical consultant. Typically, one field test should be performed per lift for each approximately 2,500 square feet of fill placement in structural areas. Additional field tests may also be performed in structural and non-structural areas at the discretion of the geotechnical consultant.

Due to the relatively shallow groundwater, use of controlled low-strength material (CLSM) should be considered in lieu of compacted fill for areas with low tolerances for surface settlements, for excavations that extend below the groundwater table, or in areas with difficult access for compaction equipment. CLSM should be placed in lifts of 5 feet or less with a 24-hour or more curing period between each lift.

8.2.4 Import Soil

Import soil should consist of coarse-grained material (50 percent or more retained on the No. 200 sieve). Import soil should have a low solubility potential of 1.0 percent or less, as evaluated by SM2540C at an extraction ratio of 1:5 (soil to water) and corrected for dilution, a low sulfate content (less than 0.1 percent), and a very low to low expansion potential (EI less than 50, as evaluated by ASTM D4829). Import soil should not contain organic matter, debris, other deleterious matter, or rocks or hard chunks larger than approximately 4 inches in nominal diameter. We further recommend that proposed import material be evaluated by the project's geotechnical consultant at the borrow source for its suitability prior to being imported to the project site. Import soil should be moisture-conditioned, placed, and compacted in accordance with the recommendations set forth in the previous section.

8.2.5 Excavations and Dewatering

Groundwater was encountered at the time of our subsurface exploration at depths as shallow as approximately 2.3 feet below the ground surface. Accordingly, earthwork operations and excavations will encounter soft and/or wet conditions. Dewatering techniques should be considered. The design, construction, and implementation of construction dewatering are the responsibility of the contractor, and should be performed by a qualified expert. Upon request Ninyo & Moore can perform in-place hydro-geologic testing and/or full-scale pump testing at this site to further evaluate these parameters. Dewatering should be performed with care so as not to cause harmful settlement of nearby foundations, utilities, pavements, or other improvements. Discharge of water from the excavations to storm water collection systems will require a construction dewatering permit. Groundwater characterization will be needed as part of the permit application.

Where encountered, drying or over-excavation of any wet or saturated soils is recommended. If the subgrade becomes disturbed, it should be compacted or removed and replaced before placing additional backfill material. Groundwater should be anticipated in utility trenches, elevator pits, or other excavations. Structures and improvements should be properly waterproofed and designed to resist buoyancy forces due to shallow groundwater. Groundwater levels will fluctuate due to seasonal variations associated with precipitation, irrigation, groundwater withdrawal or injection, and other factors.

8.2.6 Dewatering Induced Settlement

Due to relatively high moisture contents (up to 37.8 percent based on our laboratory testing), shallow groundwater (as shallow as 2.3 feet deep), and saturated conditions encountered in the subgrade soil at the site, there is a significant risk of excessive settlement and damage to existing structures due to construction dewatering. Accordingly, dewatering should be limited, where possible. A rigorous program of settlement monitoring of existing structures should be performed if dewatering is utilized during construction.

8.2.7 Temporary Excavations and Shoring

Based on the results of our subsurface explorations and in accordance with the referenced Occupational Safety and Health Administration (OSHA) regulations (OSHA, 2022), Type C soil is appropriate for native soils at the project site. Accordingly, temporary slope configurations should be consistent with the regulations provided in the referenced OSHA document considering Type C soil.

Temporary slope surfaces should be kept moist to retard raveling and sloughing. Water should not be allowed to flow over the top of excavations in an uncontrolled manner. Slopes that extend below the groundwater level will also be susceptible to instability. Stockpiled material and/or equipment should be kept back from the top of excavations a distance equivalent to the depth of the excavation or more. Workers should be protected from falling debris, sloughing, and raveling in accordance with OSHA regulations (OSHA, 2022). Temporary excavations should be observed by the project's geotechnical consultant so that appropriate additional recommendations may be provided based on the actual field conditions. Temporary excavations are time sensitive and failures are possible.

Shoring systems should be designed for the contractor by a professional engineer registered in the State of Utah. In addition to lateral earth pressures, shoring design should include surcharge loads exerted by adjacent existing roadways, structure foundations, construction equipment, construction traffic, material stockpiles, etc. located within a 1:1 (H:V) plane

extending upward from the toe of the excavation. Shoring design should discuss the anticipated top deflection of the shoring components. Depending on the anticipated top deflection of the shoring components, settlement of buildings, buried utility lines, exterior flatwork, and other improvements located within close proximity (approximately 10 feet or more) of the temporary shoring should be considered.

8.3 Utility Installation

The contractor should take particular care to achieve and maintain adequate compaction of the backfill soils around manholes, valve risers, and other vertical pipeline elements where settlements are commonly observed. Use of controlled low strength material (CLSM) or a similar material should be considered in lieu of compacted soil backfill in areas with low tolerances for surface settlement. This may also reduce permeability of the utility trench backfill.

Pipe bedding materials, placement, and compaction should meet the specifications of the pipe manufacturer and applicable municipal standards. Materials proposed for use as pipe bedding should be tested for suitability prior to use.

Special care should be exercised to avoid damaging the pipe or other structures during the compaction of the backfill. In addition, the underside (or haunches) of the buried pipe should be supported on bedding material that is compacted as described above. This may need to be performed with placement by hand or small-scale compaction equipment.

Surface drainage should be designed to divert surface water away from utility trenches. Where topography, site constraints, or other factors limit or preclude adequate surface drainage, granular bedding materials should be surrounded by a non-woven geotextile fabric (e.g., TenCate Mirafi® 140N or equivalent) to reduce the migration of fines into bedding material, which can result in severe, isolated settlements.

Development of site grading plans should consider subsurface transfer of water in utility trench backfill and the pipe bedding materials. Sandy pipe bedding materials can function as efficient conduits that convey natural and applied waters in the subsurface. Cut-off walls in utility trenches or other water-stopping measures should be implemented to reduce the rates and volumes of water transmitted along utility alignments and toward buildings, pavements, and other structures where excessive wetting of the underlying soils will be damaging. Incorporation of water cut-offs and/or outlet mechanisms for saturated bedding materials into development plans could be beneficial to the project. These measures also will reduce the risk of settlement due to loss of fine-grained backfill soils into the bedding material.

8.4 Structure Foundations

8.4.1 Conventional Spread Footings

The Administration Building and lightly loaded structures, such as retaining walls, may be supported by conventional spread foundations utilizing an allowable bearing capacity of 1,200 pounds per square foot (psf). Continuous and isolated footings should have an embedment depth of 30 inches or more below adjacent finished grade (for frost protection), and a width of 12 inches or more. As previously indicated, very soft to soft fine-grained soils with relatively high compressibility potential were encountered in our borings. Due to these soils, continuous and isolated footings may be increased in width to no more than 2 feet. To reduce the potential for excessive settlement, conventional spread foundation excavations should be over-excavated 2 feet or more and backfilled with properly placed and compacted structural fill.

The allowable bearing capacity, which was developed considering a factor of safety of 2.5, may be increased by one-third for short duration loads, such as wind or seismic. Lateral resistance for footings is presented in Section 8.6. Seismic parameters for design of structures at the site are provided in Table 3 in Section 5.3. From a geotechnical standpoint, we recommend that footings be reinforced with four No. 4 or larger reinforcing bars, two placed near the top and two near the bottom of the footings. Additional reinforcement may be recommended by the structural engineer.

8.4.2 Mat Foundations

Mat foundations should be established on at least 6 inches of Untreated Base Course placed on exposed native subgrade soils scarified and re-compacted to at least 90 percent as evaluated by ASTM D1557, or on adequately placed and compacted structural fill. Mat foundations should be embedded at least 30 inches (frost protection). Mat foundations established as recommended above may be designed for the loads provided to Ninyo & Moore as presented in Table 1. If higher loads are anticipated, Ninyo & Moore should be contacted for further recommendations.

Bending of the mat foundation from imposed foundation loads and resulting stresses within the mat foundation should be estimated using the subgrade modulus. The recommended vertical modulus of subgrade reaction, kv1, for use in design of a flexible mat foundation is 50 pounds per cubic inch (pci) applicable for a 12-inch-square loaded area. For actual mat foundation sizes, the subgrade modulus should be reduced using the following formula:

$$Kv = Kv1(B+1)/2B \quad \text{(Equation 1)}$$

Where, for a uniformly loaded mat:

Kv = vertical modulus of subgrade reaction for actual mat foundation width

Kv1 = vertical modulus of subgrade reaction for 1-foot-square loaded area in pci

B = mat foundation width in feet

For point loads on the mat, the vertical modulus of subgrade reaction need not be reduced using the formula above for the entire width of the mat or slab but rather some equivalent width which is related to the flexural stiffness of the mat relative to the underlying soil subgrade stiffness and may be estimated using the following formula:

$$B' = 14T \quad \text{(Equation 2)}$$

Where:

B' = equivalent foundation width in feet to be used in Equation 1 for B

T = thickness of mat in feet

8.5 Settlement

Based on our evaluation of spread footing bearing capacity, we anticipate that static settlement of conventional spread foundations will be on the order of 1 inch or less. We estimate static footing differential settlement of about ½-inch over a horizontal span of about 40 feet.

As previously noted, we encountered soft, compressible soil layers that are prone to consolidation settlement. Based on the conditions encountered in our borings and our evaluation of mat foundations with the provided loading, we anticipate that static settlement of foundations will generally be as noted in the table below.

Table 7 – Anticipated Settlement

Structure	Footprint (ft^2)	Approximate Weight (kips)	Bearing Pressure (ksf)	Anticipated Settlement (in)**
Headworks	4,060	3,988	0.98	<1
Chemical Mixing Box	1,100	1,117	1.02	<1
Clarifier 4	4,418	3,584	0.81	<1
Blower Building	8,166	2,000	0.24	3
MBBR Tank	9,126	13,674	1.50	4.5
Digester 3	5,027	11,427	2.27	12
Dewatering Building	3,901	1,805	0.46	2.5
Chemical Storage Building	1,296	1,000	0.77	<1***
Administration Building	6,000	2,219	1.2*	<1

Note:

* Allowable bearing capacity for conventional shallow foundations with settlement limited to less than 1 inch.

**Anticipated settlement with no mitigation.

***Based on the Chemical Storage Building being located within the footprint of the existing headworks building.

Accordingly, settlement mitigation, such as surcharge loading, should be anticipated for some of the structures. The proposed mitigation methods are discussed in the following subsections.

8.5.1 Surcharge Loading

Due to excessive long-term settlements, we recommend surcharge loading as outlined in the table below.

Table 8 – Surcharge Loading

Structure	Height of Surcharge Load (feet)*	Duration of Surcharge Load (months)
Blower Building	7	7
MBBR Tank	7	7
Digester 3	20	7
Dewatering Building	7	7

Note: *Height above existing ground surface.

Surcharge fill should be compacted to a non-yielding condition with a unit weight of 110 pcf or more. Wick drains should be installed 6 feet on-center to a depth of 50 feet below the lowest footing elevation. The contractor should install a drainage layer below the surcharge material to allow the water to freely drain out. The ground should be sloped appropriately to allow the water to drain away from the site and from any existing structures.

Prior to placement of surcharge loads, potential settlement of nearby existing structures should be evaluated and monitored.

8.5.2 Rammed Aggregate Piers

As an alternative to surcharge loading, spread foundations for the above noted structures with settlements greater than 1 inch could be founded on subgrade soils that have been remediated by installation of a Rammed Aggregate Pier (RAP) ground improvement system. A RAP system will improve the density of the underlying soils and help reduce differential settlements. Accordingly, RAP systems typically result in design bearing capacities of roughly 4 to 6 ksf.

RAP systems are typically designed for approximately 1-inch of settlement. It is important that the structures be designed with an expansion joint between buildings supported on different systems to accommodate the differences in anticipated movements.

RAPs are proprietary design-build foundation systems. Accordingly, design and installation should be performed by a specialty subcontractor, such as Geopier Foundation Company or Keller. Although RAPs are proprietary systems, Ninyo & Moore requests the opportunity to review the design parameters, including the anticipated RAP embedment depths, once the specialty subcontractor is selected.

8.6 Lateral Earth Pressures

Ninyo & Moore has evaluated "active" seismic earth pressure coefficients based on the Mononobe-Okabe equation for an active driving wedge. Our analysis considered level backfill, no wall batter, and no friction between the wall and backfill soils. Based on our calculations, Ninyo & Moore recommends that retaining walls, which are not restrained from movement at the top, be designed using an additional triangular "active" equivalent fluid unit weight as indicated on Figure 3, where appropriate. Retaining walls, which are restrained from movement at the top, should be designed using an additional triangular "at-rest" equivalent fluid unit weight as indicated on Figure 4.

Retaining walls should also be designed to resist an "active" and "at-rest" surcharge pressure as shown on Figure 3 and Figure 4. The value for "q" represents the pressure induced by adjacent light loads, uniform slab, or traffic loads plus any adjacent footing loads.

For passive resistance to lateral loads, we recommend that a passive lateral earth pressure as shown on Figure 3 be used up to a value of 1,500 psf. This value assumes that the ground surface is horizontal for a distance of 10 feet, or three times the height generating the passive pressure, whichever is more. We recommend that the upper 12 inches of soil not protected by pavement or a concrete slab be neglected when calculating passive resistance. For frictional resistance to lateral loads, we recommend that a coefficient of friction of 0.49 be used between soil and soil contacts. A coefficient of friction of 0.31 may be used between soil and concrete contacts. Passive and frictional resistances may be used in combination, provided the passive resistance does not exceed one-half of the total allowable resistance.

8.7 Concrete Slab-On-Grade Floors

Concrete slab-on-grade floors should be designed by the project's structural engineer based on anticipated loading conditions. Ninyo & Moore recommends that conventional concrete slab-on-grade floors for this project be founded on 6 inches of Untreated Base Course overlying medium dense to very dense native granular soils, stiff to hard native fine-grained soils, or a zone of adequately placed and compacted structural fill (reworked native or import soils). Aggregate base

underlying concrete slab-on-grade floors should be compacted to 95 percent or more of the laboratory maximum dry density (ASTM D1557).

Floor slabs should be 4 inches or more in thickness and reinforced with No. 3 steel reinforcing bars placed at 18 inches on-center both ways. Reinforcement of the slab should be placed at mid-height. We recommend that “chairs” be utilized to aid in the placement of the reinforcement. Increased slab thickness and reinforcement may be recommended by the structural engineer. As a means to reduce shrinkage cracks, we recommend that conventional slab-on-grade floors be provided with control joints in accordance with the recommendations of a qualified structural engineer. Recommendations regarding concrete utilized in construction of floor slabs are provided in Section 8.11. As an alternative to slab reinforcement with steel reinforcing bars, post-tensioned slabs designed by a qualified structural engineer may be considered.

Ninyo & Moore recommends that a moisture barrier be provided by a membrane placed beneath concrete slab-on-grade floors, particularly in areas where moisture-sensitive flooring is to be used. The membrane should overlie the previously described compacted base material. The membrane should consist of visqueen 10 mils in thickness. If flooring systems, including the adhesives, are particularly sensitive to moisture vapor, a more robust membrane/moisture barrier should be considered, such as Stego Wrap, which is 15 mils in thickness with a permeance less than 0.02 grains per square foot per hour (perms) as evaluated by ASTM E96. This membrane should overlie compacted base material and be placed directly under the floor slab. A pre-pour planning meeting should also be considered to resolve water vapor emission and concrete curing considerations and to establish means for reducing slab curl.

Floor slabs should be constructed so that it “floats” independent of the foundations. Floor slabs should be separated from bearing walls and columns with expansion joints, which allow unrestrained vertical movement. Joints should be observed periodically, particularly during the first several years after construction. Slab movement can cause previously free-slipping joints to bind. Measures should be taken so that slab isolation is maintained in order to reduce the likelihood of damage to walls and other interior improvements.

Slabs associated with vaults, or any other subgrade structures that extend several feet below the ground should be constructed as waterproof structures that can also resist the buoyancy forces (depending on their proximity to the groundwater table).

8.8 Exterior Concrete Flatwork

Ground-supported concrete flatwork may be subject to soil-related movements resulting from frost heave/settlement. Thus, where these types of elements abut rigid building foundations or isolated/suspended structures, differential movements should be anticipated. We recommend that flexible joints be provided in this situation to allow for differential movement.

Exterior concrete flatwork, such as walkways, should be founded on 6 inches of Untreated Base Course overlying medium dense to very dense native granular soils, stiff to hard native fine-grained soils, or a zone of compacted structural fill that meets the recommendations described in Section 8.2.3 of this report. Untreated Base Course should be compacted to 95 percent or more relative compaction, as evaluated by ASTM D1557.

To reduce the potential for shrinkage cracks, the flatwork should be constructed with control joints spaced approximately 5 feet apart for walkways and approximately 10 feet on-center each way for larger slabs. Crack control joint spacing should be in accordance with recommendations of a qualified structural engineer. Reduced joint spacing may be recommended by the structural engineer.

Formation of shrinkage cracks in concrete slabs, and other cracks due to minor soil movement, may be further reduced by utilizing steel reinforcement, such as welded wire mesh. However, due to the inherent difficulty in positioning welded wire mesh in the middle of concrete flatwork, other crack control methods should be considered, such as placement in the concrete of No. 3 steel reinforcing bars at approximately 24 inches on-center each way. Reinforcement of the flatwork should be placed at approximately mid-height in the concrete utilizing “chairs.”

Exterior concrete flatwork, curbs, and gutters should be constructed in accordance with the recommendations of the project’s civil or structural engineer and governing agency requirements. Recommendations regarding concrete utilized in construction of proposed improvements are provided in Section 8.11.

8.9 Construction in Cold or Wet Weather

During construction, the site should be graded such that surface water can drain readily away from the structure and improvement areas. It is important to avoid ponding of water in or near excavations. Water that accumulates in excavations should be promptly pumped out or otherwise removed and these areas should be allowed to dry out before resuming construction. Berms, ditches, and similar means may be used to decrease stormwater entering the work area and to efficiently convey it to appropriate outlets off site.

Earthwork activities undertaken during the cold weather season may be difficult and should be done by an experienced contractor. Fill should not be placed on top of frozen soils. The frozen soils should be removed prior to placement of new engineered fill or other construction material. Frozen soil should not be used as structural fill or backfill. The frozen soil may be reused (provided it meets the selection criteria) once it has thawed completely. In addition, compaction of the soils may be more difficult due to the viscosity change in water at lower temperatures.

If construction proceeds during cold weather, foundations, slabs, or other concrete elements should not be placed on frozen subgrade soil. Frozen soil should either be removed from beneath concrete elements, or thawed and re-compacted. To limit the potential for soil freezing, the time between excavation and construction should be minimized. Blankets, straw, soil cover, or heating may be used to decrease the potential of soil freezing.

8.10 Frost Heave

Site soils are susceptible to frost heave if allowed to become saturated and exposed to freezing temperatures and repeated freeze/thaw cycling. The formation of ice in the underlying soils can result in 2 or more inches of heave of pavements, flatwork, and other hardscaping in sustained cold weather. A portion of this movement may be recovered when the soils thaw, but due to loss of soil density, some degree of displacement will remain. Frost heave of hardscaping could also result in areas of fine-grained subgrade soils.

In areas where hardscape movements are a design concern (i.e. exterior flatwork located adjacent to the building within the doorway swing zone), replacement of the subgrade soils with 3 or more feet of clean, coarse sand or gravel, or supporting the element on foundations similar to the building, or spanning over a void should be considered. Detailed recommendations in this regard can be provided upon request.

8.11 Concrete and Corrosion Considerations

The corrosion potential of on-site soils to concrete and metal was evaluated in the laboratory using representative samples obtained from the exploratory borings. Results of these tests are presented in Appendix C. Recommendations regarding concrete to be utilized in construction of proposed improvements and for metal in contact with on-site soils are provided in the following sections.

8.11.1 Concrete

Chemical tests performed on selected samples of on-site soils indicated sulfate contents of 68 to 237 mg/kg (ppm). Based on review of the referenced International Building Code (ICC,

2018) and American Concrete Institute manual (ACI, 2019), the tested soils are considered to have a sulfate exposure class of S0 to S1. Additionally, concrete in contact with on-site soil is anticipated to have a freeze/thaw exposure class of F2. Accordingly, we recommend that concrete in contact with on-site soils, along with subsurface walls up to 12 inches above finished grade have a design compressive strength of 4,500 psi or more, a water-cement ratio of 0.45 percent or less by weight, contain Type II cement, and contain 5.5 to 7.5 percent air-entrainment, as specified by ACI 318-19 (ACI, 2019). It is recommended that reinforcing bars in cast-against-grade concrete be covered by approximately 3 inches or more of concrete. Concrete should be placed with an approximate 4-inch slump and good densification procedures should be used during placement to reduce the potential for honeycombing. Concrete samples should be obtained, as indicated by ACI manual Section 318 (ACI, 2019), and the slump should be tested at the site by the project's geotechnical consultant. Structural concrete should be placed in accordance with American Concrete Institute (ACI, 2019) and project specifications.

8.11.2 Metal in Contact with On-Site Soils

Chemical tests performed on selected samples of on-site soils indicated low to very severe corrosion potential to normal grade steel. Accordingly, Ninyo & Moore recommends that corrosion reduction methods be implemented for this project for metal in contact with soil. These corrosion reduction methods may include utilization of protective coatings, pipe sleeving, and/or appropriate cathodic protection as recommended by a qualified corrosion engineer. Where permitted by jurisdictional building codes, the use of plastic pipes for buried utilities should also be considered.

8.12 Moisture Infiltration Reduction and Surface Drainage

Infiltration of water into subsurface soils can lead to soil movement and associated distress, and chemically and physically related deterioration of concrete structures. To reduce the potential for infiltration of moisture into subsurface soils at the site, we recommend the following:

- Positive drainage should be established and maintained away from the structures. Positive drainage may be established by providing a surface gradient for paved areas of 2 percent or more for a distance of 10 feet or more away from structure perimeters. For unpaved areas, positive drainage may be established by a slope of 5 percent or more for a distance of 10 feet or more away from structure perimeters, where possible.

- Adequate surface drainage should be provided to channel surface water away from on-site structures and to a suitable outlet such as a storm drain or the street. Adequate surface drainage may be enhanced by utilization of graded swales, area drains, and other drainage devices. Surface run-off should not be allowed to pond near structures.

- Building roof drains should have downspouts tightlined to an appropriate outlet, such as a storm drain or the street. If tightlining of the downspouts is not practicable, they should discharge 5 feet or more away from buildings or onto paved areas that slope away from structures. Downspouts should not be allowed to discharge onto the ground surface adjacent to building foundations or concrete flatwork.

- Ninyo & Moore recommends that low-water use (drip irrigated) landscaping be utilized on site, particularly within 5 feet of buildings and exterior site improvements, including areas of concrete flatwork and masonry block walls. Spray irrigation should not be used within 5 feet of buildings. For drip irrigated foundation plating located within 5 feet of buildings, we recommend incorporating a drainage system that drains the excess irrigation water away from this zone or soil moisture probes to prevent over watering.

- Irrigation heads should be oriented so that they spray away from building and block wall surfaces.

- Utility trenches should be backfilled with compacted, low permeability fill (i.e. permeability of 5-10 cm/s or less) within 5 feet of buildings. Planters, if any, should be maintained 10 feet or more from buildings and constructed with closed bottoms or with drainage systems to drain excess irrigation away from buildings.

- The facility owner should develop a program for the continued maintenance of the irrigation systems, which should be performed periodically, to prevent overwatering of landscaping within 5 to 10 feet of building perimeters.

8.13 Observation and Testing

The geotechnical consultant should perform appropriate observation and testing services during fill placement, grading, and construction operations. These services should include observation of removal of soft, loose, undocumented fill, or otherwise unsuitable soils, evaluation of subgrade conditions where soil removals are performed, and performance of observation and testing services during placement and compaction of structural fill and backfill soils. The geotechnical consultant should also perform observation and testing services during placement of concrete, mortar, grout, asphalt concrete, and steel reinforcement.

The recommendations provided in this report are based on the assumption that Ninyo & Moore will provide geotechnical observation, testing, and inspection services during grading and construction. In the event that it is decided not to utilize the services of Ninyo & Moore during construction, we request that the selected consultant provide the client with a letter (with a copy sent to Ninyo & Moore) indicating that they fully understand Ninyo & Moore's recommendations, and that they are in full agreement with the design parameters and recommendations contained in this report.

8.14 Plan Review

The recommendations presented in this report are based on preliminary design information for the proposed project, as provided by South Davis Sewer District personnel, and on the findings of our geotechnical evaluation. When finished, project plans and specifications should be reviewed by the geotechnical consultant prior to submitting the plans and specifications for bid. Additional field exploration and laboratory testing may be needed upon review of the project design plans.

8.15 Pre-Construction Meeting

We recommend that a pre-construction meeting be held. The owner or the owner's representative, the architect, the civil engineer, the contractor, and the geotechnical consultant should be in attendance to discuss the plans and the project.

9 LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports

prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. The conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. Changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

10 REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), 1993, AASHTO Guide for Design of Pavement Structures: Fourth Edition, Volume 1 and Volume 2.

American Concrete Institute (ACI), 2019, Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19).

American Society of Civil Engineers (ASCE), 2016, Minimum Design Loads for Building and Other Structures, Standard 7-16.

Applied Technology Council (ATC), 2023, Hazards by Location, https://hazards.atcouncil.org/#/.

ASTM International (ASTM), 2022, Annual Book of ASTM Standards, Section 4 – Construction.

Google Earth Website, Aerial photographs of the West Bountiful area, Utah: http://earth.google.com accessed on May 8, 2023.

International Code Council (ICC), 2018, International Building Code (IBC).

Lowe, M., 2018, Geologic map of the Farmington quadrangle, Salt Lake and Davis Counties, Utah. M-279dm. UGS. 1:24,000 scale.

Ninyo & Moore proprietary in-house data.

Occupational Safety and Health Administration (OSHA), 2022, OSHA Standards for the Construction Industry, 29 CFR Part 1926: dated January 1.

Rocscience, 2022, Settle3, Version 5.015, 64 bit

United States Geological Survey (USGS), 2023, Quaternary Faults and Fold Database of the United States: http://earthquakes.usgs.gov/qfaults.

United States Geological Survey (USGS), 2014, National Seismic Hazards Maps – Source Parameters: https://earthquake.usgs.gov/cfusion/hazfaults_2014_search.

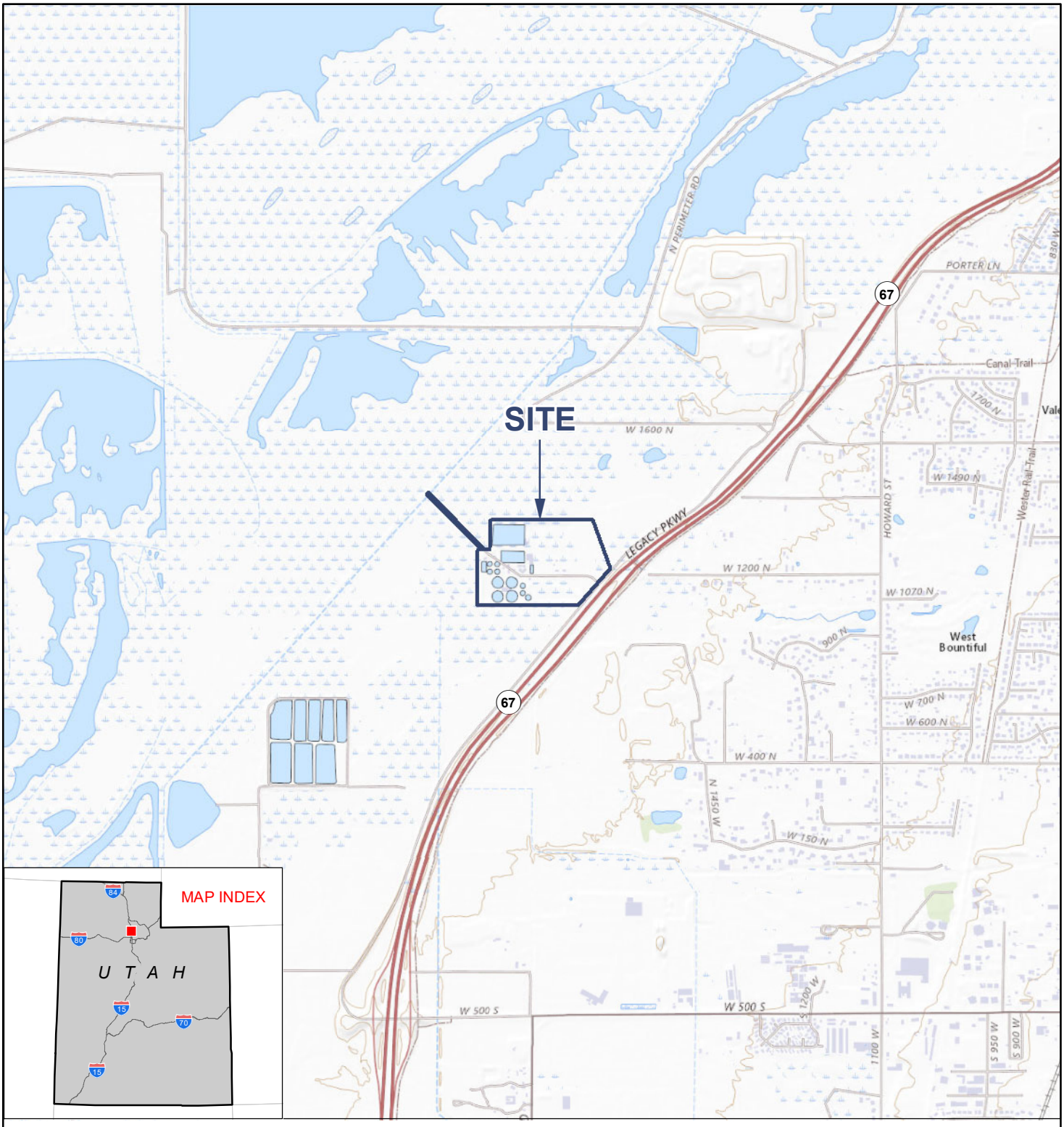
Utah Department of Transportation (UDOT), 2022, 2023 Standard Specifications for Road and Bridge Construction: dated May 10.

Utah Geological Survey (UGS), 2008a, Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah, compiled by Christenson, G. E. and Shaw, L.M.

Utah Geological Survey (UGS), 2008b, Surface Fault Rupture Special Study Areas, Wasatch Front and Nearby Areas, Utah, compiled by Christenson, G. E. and Shaw, L.M.

Utah Geological Survey (UGS), 2023, Utah Geologic Hazards Portal: https://geology.utah.gov/apps/hazards/

FIGURES



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NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: ESRI, USGS, 2023

N

FEET

0 1,900 3,800

FIGURE 1

SITE LOCATION

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

800272001 | 7/23

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

LEGEND

HA-2 TD=9.0	HAND AUGER BORING TD=TOTAL DEPTH IN FEET
B-12 TD=56.5	BORING TD=TOTAL DEPTH IN FEET
	ReMi SURVEY LINE
	SITE BOUNDARY

N

FEET

0 350 700

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: GOOGLE EARTH, 2023

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FIGURE 2A

EXPLORATION LOCATIONS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

800272001 | 7/23

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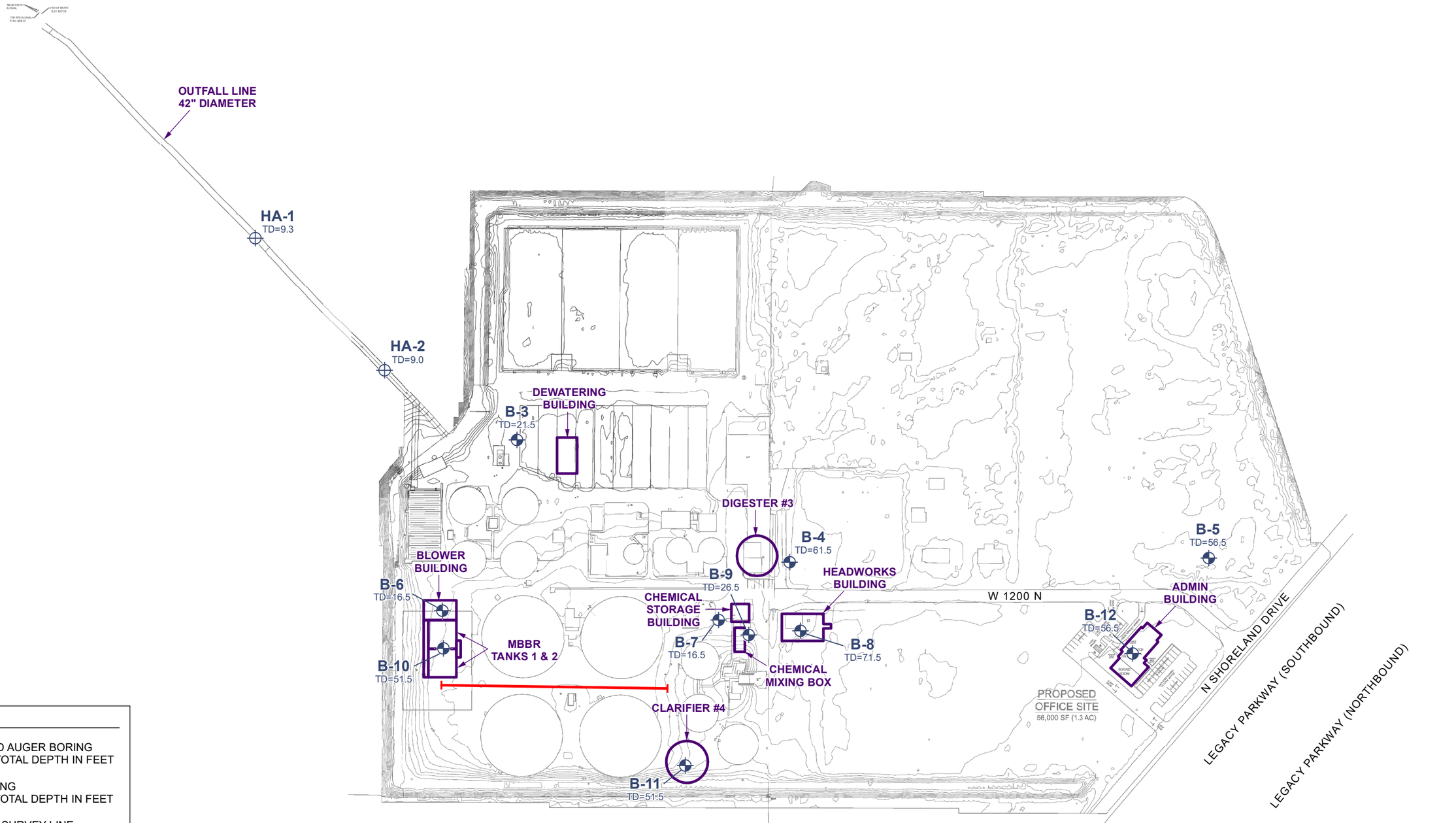

LEGEND

HA-2 TD=9.0	HAND AUGER BORING TD=TOTAL DEPTH IN FEET
B-12 TD=56.5	BORING TD=TOTAL DEPTH IN FEET
	ReMi SURVEY LINE

N

FEET
0 200 400

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: SITE PLANS - AQUA ENGINEERING, DATED: 2/24/2023 & 6/14/2023.

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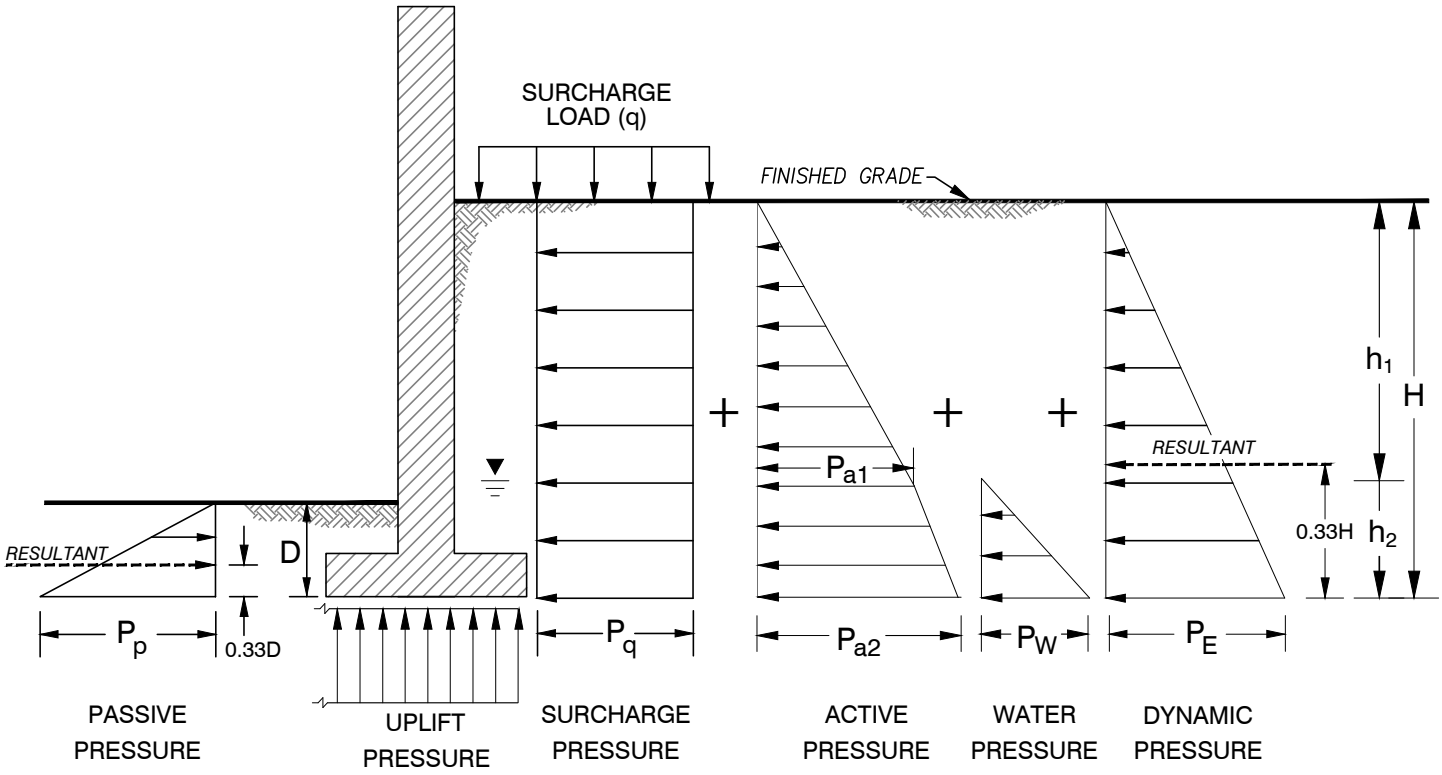
FIGURE 2B

EXPLORATION LOCATIONS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST, 1200 NORTH, WEST BOUNTIFUL, UTAH

800272001 | 7/23

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants



NOTES:

1. ACTIVE LATERAL EARTH PRESSURES, P_{a1} AND P_{a2}
   $P_{a1} = 40\ h_1$ psf
   $P_{a2} = 40\ h_1 + 20\ h_2$ psf
2. HYDROSTATIC PRESSURE, P_w
   $P_w = 62.4\ h_2$ psf
3. UPLIFT PRESSURE, P_u
   $P_u = 62.4\ h_2$ psf
4. DYNAMIC PRESSURE, $P_E = 14H$ psf
5. SURCHARGE PRESSURE, $P_q = 0.38q$
6. H, h_1 AND h_2 ARE IN FEET
7. ▼ GROUNDWATER TABLE
8. ASSUMES LEVEL BACKFILL.

NOT TO SCALE

3 304292001 D-YRW.DWG

FIGURE 3

LATERAL EARTH PRESSURES FOR YIELDING RETAINING WALLS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

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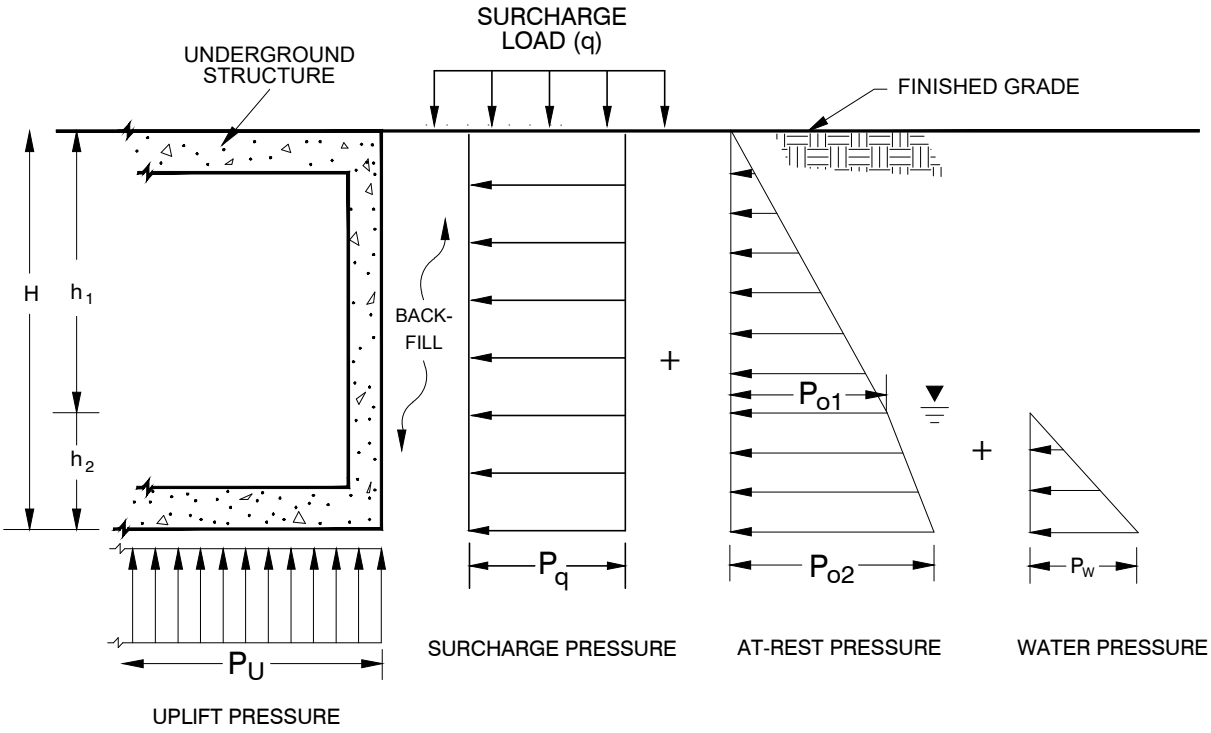


NOTES:

1. AT-REST LATERAL EARTH PRESSURES, P_{o1} AND P_{o2}
   $P_{o1} = 58\ h_1$ psf
   $P_{o2} = 58\ h_1 + 29\ h_2$ psf
2. HYDROSTATIC PRESSURE, P_w
   $P_w = 62.4\ h_2$ psf
3. UPLIFT PRESSURE, P_u
   $P_u = 62.4\ h_2$ psf
4. SURCHARGE PRESSURE, $P_q = 0.55q$
5. H, h_1 AND h_2 ARE IN FEET
6. ▼ GROUNDWATER TABLE
7. ASSUMES LEVEL BACKFILL.

NOT TO SCALE

FIGURE 4

LATERAL EARTH PRESSURES FOR RESTRAINED RETAINING WALLS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

800272001 I 7/23

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

APPENDIX A

Boring Logs

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Soil Samples
Disturbed soil samples were obtained in the field using the following methods.

Bulk Soil Samples
Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Sampler
Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. In general accordance with ASTM D1586, the sampler was driven into the ground with a 140-pound hammer free-falling from a height of 30 inches and the number of blows recorded on the boring logs as an index to the relative resistance of the materials sampled. Soil samples were observed and removed from the sampler, bagged, sealed, and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples
Relatively undisturbed soil samples were obtained in the field using a modified split barrel drive sampler. The sampler, with an external diameter of 3.0 inches, was lined with 1-inch-long, thin, brass rings with inside diameters of 2.4 inches. In general accordance with ASTM D3550, the sampler was driven into the ground with a 140-pound hammer free-falling from a height of 30 inches and the number of blows recorded on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

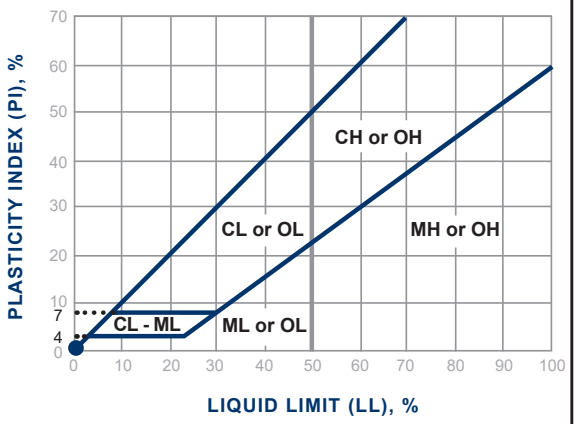
Soil Classification Chart Per ASTM D 2488

Primary Divisions			Secondary Divisions	
			Group Symbol	Group Name
COARSE-GRAINED SOILS more than 50% retained on No. 4 sieve	**GRAVEL** more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with clay
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	**SILT and CLAY** liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
	Highly Organic Soils		PT	Peat

Grain Size

Description		Sieve Size	Grain Size	Approximate Size
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

Plasticity Chart



Apparent Density - Coarse-Grained Soil

Apparent Density	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

Consistency - Fine-Grained Soil

Consis-tency	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

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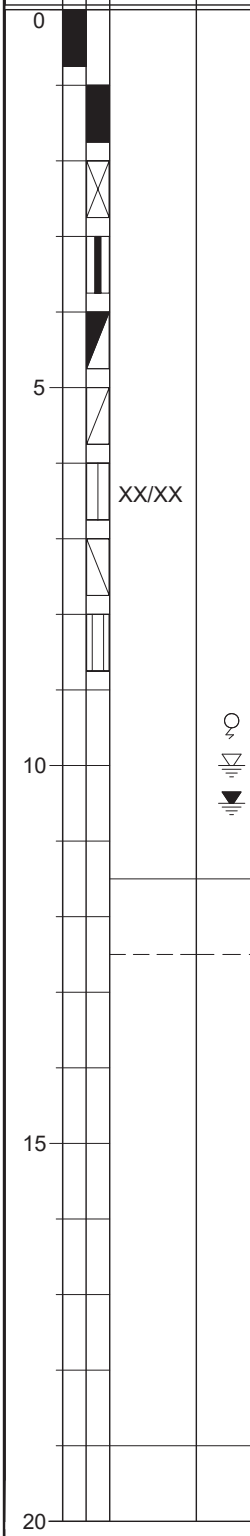
USCS METHOD OF SOIL CLASSIFICATION

BORING LOG EXPLANATION SHEET



Bulk sample.

Modified split-barrel drive sampler.

No recovery with modified split-barrel drive sampler.

Sample retained by others.

Standard Penetration Test (SPT).

No recovery with a SPT.

Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.

No recovery with Shelby tube sampler.

Continuous Push Sample.

Seepage.

Groundwater encountered during drilling.

Groundwater measured after drilling.

SM

MAJOR MATERIAL TYPE (SOIL):

Solid line denotes unit change.

CL

Dashed line denotes material change.

Attitudes: Strike/Dip
b: Bedding
c: Contact
j: Joint
f: Fracture
F: Fault
cs: Clay Seam
s: Shear
bss: Basal Slide Surface
sf: Shear Fracture
sz: Shear Zone
sbs: Shear Bedding Surface

The total depth line is a solid line that is drawn at the bottom of the boring.

DATE DRILLED 6/8/23 HAND AUGER NO. HA-1

GROUND ELEVATION 4,210' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING Hand Auger

DRIVE WEIGHT 15 lbs. DROP 20"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	DCP BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	TOPSOIL: Unit is approximately 3 inches thick. FILL: Reddish brown, dry, dense, silty SAND with gravel.
		■	13/1.75" 19/1.75" 16/1.75"				CL	Light brown, moist, hard, lean CLAY; few to little sand.
		■					CL	NATIVE SOIL: Grayish blue, moist, stiff, lean CLAY; organics in upper 6 inches.
				▽				Wet.
5		■	12/1.75" 8/1.75" 11/1.75"					Very stiff.
								Light brown.
		■	7/1.75" 12/1.75" 12/1.75"					Hard.
10								Total Depth = 9.3 feet. Groundwater was encountered at a depth of approximately 4.5 feet during excavation. Backfilled on 6/8/23. Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
15								
20								

DATE DRILLED 6/8/23 HAND AUGER NO. HA-2

GROUND ELEVATION 4,211' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING Hand Auger

DRIVE WEIGHT 15 lbs. DROP 20"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	DCP BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SM	FILL: Reddish brown, dry, dense, silty SAND with gravel.
		11/1.75" 10/1.75" 12/1.75"				CL	Light brown, moist, hard, lean CLAY with sand.
		6/1.75" 7/1.75" 9/1.75"					Very stiff.
						CL	NATIVE SOIL: Grayish brown, moist, very stiff, lean CLAY with sand.
5			▽				Wet. Light brown; sand grades out.
		12/1.75" 17/1.75" 20/1.75"					Hard.
		9/1.75" 12/1.75" 14/1.75"					Total Depth = 9.0 feet. Groundwater was encountered at a depth of approximately 5.0 feet during excavation. Backfilled on 6/8/23.
10							Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report.
							The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
15							
20							

FIGURE A- 2

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/9/23 BORING NO. B-3

GROUND ELEVATION 4,215' ± (MSL) SHEET 1 OF 2

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							ASHPALT CONCRETE: Unit is approximately 5.5 inches thick.
						SC	AGGREGATE BASE:
						CL	Brown, moist, medium dense, clayey SAND with gravel. Unit is approximately 6.5 inches thick.
		4/6" 7/6" 7/6"					NATIVE SOIL: Grayish brown, moist, very stiff, lean CLAY; trace gravel.
		3/6" 8/6" 24/6"	10.1	102.2			Hard.
5		9/6" 6/6" 8/6"					Very stiff.
		2/6" 7/6" 7/6"	23.5	98.2			Wet.
						SM	Brown, wet, loose, silty SAND.
10							
15		2/6" 1/6" 3/6"				CL	Light brown, wet, firm, lean CLAY.
20							

FIGURE A- 3

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

800272001 | 7/23

DATE DRILLED 5/9/23 BORING NO. B-3

GROUND ELEVATION 4,215' ± (MSL) SHEET 2 OF 2

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		■	2/6" 1/6" 3/6"	37.8	80.4	▨	CL	NATIVE SOIL: (Continued) Gray, wet, firm, lean CLAY.
								Total Depth = 21.5 feet. Groundwater was encountered at a depth of approximately 14.0 feet during drilling. Groundwater measured at a depth of 8.5 feet approximately 24 hours after drilling. Backfilled and patched on 5/10/23. Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
25								
30								
35								
40								

DATE DRILLED 5/11/23 BORING NO. B-4

GROUND ELEVATION 4,212' ± (MSL) SHEET 1 OF 4

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						GC	FILL:
						CL	Brown, moist, medium dense, clayey GRAVEL.
		16/6" 8/6" 6/6"	18.1	93.5			Brown, moist, very stiff, lean CLAY with gravel.
						CL	NATIVE SOIL:
		3/6" 4/6" 6/6"					Light brown, moist, stiff, lean CLAY; few sand.
5							
			▽				Wet.
		4/6" 5/6" 7/6"					
		2/6" 3/6" 4/6"					
10							
15							Trace sand and gravel.
		2/6" 3/6" 4/6"					
			38.3				
20							

FIGURE A- 5

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/11/23 BORING NO. B-4

GROUND ELEVATION 4,212' ± (MSL) SHEET 2 OF 4

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		2/6" 2/6" 3/6"				CL	NATIVE SOIL: (Continued) Gray, wet, firm, lean CLAY.
25		2/6" 3/6" 4/6"	31.9	86.6			Stiff.
30		2/6" 1/6" 2/6"					Soft.
35		2/6" 4/6" 5/6"					Stiff; few sand.
40							

FIGURE A- 6

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/11/23 BORING NO. B-4

GROUND ELEVATION 4,212' ± (MSL) SHEET 3 OF 4

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40		4/6" 3/6" 3/6"				CL	NATIVE SOIL: (Continued) Gray, wet, stiff, lean CLAY; few sand.
45		7/6" 10/6" 13/6"	29.2	90.0			Very stiff; trace sand.
50		4/6" 3/6" 5/6"					Stiff.
						SP	Gray, wet, medium dense, poorly graded SAND with gravel.
55		4/6" 5/6" 7/6"	30.4	88.9		CL	Gray, wet, stiff, lean CLAY.
60							

FIGURE A- 7

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/11/23 BORING NO. B-4

GROUND ELEVATION 4,212' ± (MSL) SHEET 4 OF 4

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
60			4/6" 5/6" 6/6"				CL	NATIVE SOIL: (Continued) Gray, wet, very stiff, lean CLAY; few sand.
								Total Depth = 61.5 feet. Groundwater was encountered at a depth of approximately 6.0 feet during drilling. Backfilled on 5/12/23. Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
65								
70								
75								
80								

DATE DRILLED 5/15/23 BORING NO. B-5

GROUND ELEVATION 4,212' ± (MSL) SHEET 1 OF 3

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY JFS LOGGED BY JFS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SP-SM	FILL: Light brown, moist, dense, poorly graded SAND with silt and gravel.
		6/6" 10/6" 9/6"	6.8	119.8		CL	Dark brown, moist, very stiff, lean CLAY; few sand and gravel; trace organics.
		3/6" 3/6" 6/6"	▽			CL	NATIVE SOIL: Light brown, moist, very stiff, sandy lean CLAY. Wet.
5							
		3/6" 2/6" 2/6"	33.5	87.0			Brown; firm; few gravel.
		2/6" 1/6" 2/6"					Soft; with sand.
10							
15		5/6" 9/6" 11/6"	25.2	97.2			Sand grades out.
20							

FIGURE A- 9

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/15/23 BORING NO. B-5

GROUND ELEVATION 4,212' ± (MSL) SHEET 2 OF 3

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY JFS LOGGED BY JFS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		2/6" 3/6" 7/6"				CL	NATIVE SOIL: (Continued) Bluish gray, wet, stiff, lean CLAY.
25		2/6" 3/6" 4/6"	37.2	83.1		CH	Bluish gray, wet, stiff, fat CLAY.
30		2/6" 3/6" 3/6"	25.5			CL	Bluish gray, wet, stiff, lean CLAY; few sand.
35		3/6" 4/6" 4/6"	36.7	79.7			Sand grades out.
40							

FIGURE A- 10

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/15/23 BORING NO. B-5

GROUND ELEVATION 4,212' ± (MSL) SHEET 3 OF 3

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY JFS LOGGED BY JFS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40		2/6" 2/6" 2/6"				CL	NATIVE SOIL: (Continued) Bluish dark gray, wet, firm, lean CLAY.
45		3/6" 5/6" 7/6"	30.3	88.4			Stiff; sandy; interbedded layers of sand up to 1/8 inch thick.
50		4/6" 5/6" 9/6"					Very stiff; with sand.
55		6/6" 11/6" 14/6"	26.9	95.0			Sand grades out.
60							Total Depth = 56.5 feet. Groundwater was encountered at a depth of approximately 4.0 feet during drilling. Backfilled on 5/15/23. Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

DATE DRILLED 5/9/23 BORING NO. B-6

GROUND ELEVATION 4,212' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							TOP SOIL: Unit is approximately 2 inches thick.
	Driven	8/6" 4/6" 6/6"	14.3	90.2		CL	FILL: Brown, moist, stiff, lean CLAY; trace sand.
	Driven	4/6" 6/6" 8/6"				CL	NATIVE SOIL: Light brown, moist, very stiff, lean CLAY.
5							Stiff.
	Driven	4/6" 5/6" 7/6"	23.4	96.6			
						ML	Brown, wet, loose, SILT with sand.
						CL	Brown, wet, stiff, lean CLAY.
	Driven	3/6" 4/6" 4/6"					
10							Few sand; trace gravel.
			30.9				
15							Gray.
	Driven	3/6" 4/6" 7/6"	25.7	99.8			
							Total Depth = 16.5 feet. Groundwater was encountered at a depth of approximately 11.0 feet during drilling. Backfilled on 5/9/23.
20							Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

FIGURE A- 12

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/9/23 BORING NO. B-7

GROUND ELEVATION 4,211' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						GM	ASPHALT CONCRETE: Unit is approximately 2.5 inches thick.
						CL	AGGREGATE BASE: Brown, moist, medium dense, silty GRAVEL. Unit is approximately 9.5 inches thick.
		2/6" 2/6" 3/6"					FILL: Dark brown, moist, firm, lean CLAY; trace sand.
		1/6" 2/6" 3/6"	▼ 14.0	102.4			Grayish dark brown. Wet.
5						CL	NATIVE SOIL: Gray, wet, soft, lean CLAY; trace sand.
		0/6" 2/6" 1/6"					
		1/6" 1/6" 1/6"					
10							
15		2/6" 1/6" 4/6"					Firm; sand grades out.
20							Total Depth = 16.5 feet. Groundwater was encountered at a depth of approximately 8.5 feet during drilling. Groundwater measured at a depth of 4 feet approximately 48 hours after drilling. Backfilled and patched on 5/11/23. Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

FIGURE A- 13

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/12/23 BORING NO. B-8

GROUND ELEVATION 4,211' ± (MSL) SHEET 1 OF 4

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY JFS LOGGED BY JFS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0		5/6" 3/6" 4/6"				SP-SM	FILL: Light brown, dry, dense, poorly graded SAND with silt and gravel. Brown; moist; loose; few to little gravel.
5		3/6" 5/6" 6/6"	24.3	99.3		CL	NATIVE SOIL: Brownish gray, moist, stiff, lean CLAY; few sand.
		2/6" 3/6" 3/6"					Wet.
10		3/6" 6/6" 7/6"					Very stiff; sand grades out.
15		3/6" 4/6" 5/6"	28.5	93.4			Gray; stiff.
20							

FIGURE A- 14

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/12/23 BORING NO. B-8

GROUND ELEVATION 4,211' ± (MSL) SHEET 2 OF 4

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY JFS LOGGED BY JFS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		2/6" 1/6" 3/6"				CL	NATIVE SOIL: (Continued) Dark gray, wet, firm, lean CLAY; trace sand.
25		2/6" 3/6" 4/6"	31.0	87.4		CH	Bluish dark gray, wet, stiff, fat CLAY.
30		2/6" 1/6" 3/6"	29.0			CL	Bluish dark gray, wet, firm, lean CLAY.
35		3/6" 3/6" 5/6"	37.8	82.4			Dark gray; stiff.
40							

FIGURE A- 15

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/12/23 BORING NO. B-8

GROUND ELEVATION 4,211' ± (MSL) SHEET 3 OF 4

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY JFS LOGGED BY JFS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40		2/6" 2/6" 4/6"				CL	NATIVE SOIL: (Continued) Bluish dark gray, wet, stiff, lean CLAY; few sand.
45		4/6" 6/6" 11/6"	30.4	91.0			Very stiff.
50		2/6" 2/6" 3/6"					Firm.
55		2/6" 3/6" 3/6"	28.8	91.9			
60							

FIGURE A- 16

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/12/23 BORING NO. B-8

GROUND ELEVATION 4,211' ± (MSL) SHEET 4 OF 4

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY JFS LOGGED BY JFS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
60		5/6" 8/6" 11/6"				CL	NATIVE SOIL: (Continued) Dark gray, wet, very stiff, lean CLAY; trace sand.
65		5/6" 7/6" 8/6"	26.6	96.1		ML	Dark gray, wet, medium dense, SILT.
70		4/6" 9/6" 11/6"					
75							Total Depth = 71.5 feet. Groundwater was encountered at a depth of approximately 6.0 feet during drilling. Backfilled on 5/12/23. Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
80							

DATE DRILLED 5/11/23 BORING NO. B-9

GROUND ELEVATION 4,212' ± (MSL) SHEET 1 OF 2

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							TOP SOIL: Unit is approximately 3 inches thick.
		6/6" 9/6" 13/6"	31.9	78.1		CL	FILL: Dark brown, moist, very stiff, lean CLAY; few sand.
5		2/6" 4/6" 3/6"	▼			CL	NATIVE SOIL: Light brown, wet, stiff, lean CLAY; few sand.
		2/6" 4/6" 7/6"	28.1	90.9			Sand grades out.
			▽				
10		3/6" 4/6" 5/6"					
15		3/6" 3/6" 4/6"	28.6	92.6			Gray.
20							

FIGURE A- 18

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

800272001 | 7/23

DATE DRILLED 5/11/23 BORING NO. B-9

GROUND ELEVATION 4,212' ± (MSL) SHEET 2 OF 2

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		2/6" 1/6" 2/6"				CL	NATIVE SOIL: (Continued) Gray, wet, soft, lean CLAY.
25		2/6" 2/6" 4/6"	35.8	82.6			Firm.
30							Total Depth = 26.5 feet. Groundwater was measured at a depth of approximately 8.0 feet during drilling. Groundwater measured at a depth of 3.7 feet approximately 96 hours after drilling. Backfilled on 5/15/23. Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
35							
40							

DATE DRILLED 5/10/23 BORING NO. B-10

GROUND ELEVATION 4,211' ± (MSL) SHEET 1 OF 3

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							TOP SOIL: Unit is approximately 2 inches thick.
		2/6" 2/6" 4/6"	21.4	96.0		CL	FILL: Brown, moist, firm, lean CLAY; trace gravel.
		3/6" 5/6" 6/6"					Very stiff.
5		3/6" 4/6" 7/6"	▽			CL	NATIVE SOIL: Brown, wet, stiff, lean CLAY.
		2/6" 3/6" 4/6"				ML	Brown, wet, loose, SILT.
10							
15		4/6" 6/6" 5/6"	33.0			CL	Light brown, wet, stiff, lean CLAY.
20							

FIGURE A- 20

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/10/23 BORING NO. B-10

GROUND ELEVATION 4,211' ± (MSL) SHEET 2 OF 3

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		2/6" 1/6" 3/6"				CL	NATIVE SOIL: (Continued) Gray, wet, firm, lean CLAY.
25		4/6" 5/6" 6/6"					Stiff.
30		3/6" 5/6" 6/6"					Very stiff.
35		2/6" 4/6" 5/6"	33.0	86.4			Stiff; trace sand.
40							

FIGURE A- 21

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/10/23 BORING NO. B-10

GROUND ELEVATION 4,211' ± (MSL) SHEET 3 OF 3

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40		3/6" 4/6" 5/6"				CL	NATIVE SOIL: (Continued) Gray, wet, stiff, lean CLAY; trace sand.
45		4/6" 11/6" 12/6"	24.3	93.5		SM	Gray, wet, medium dense, silty SAND.
50		12/6" 24/6" 19/6"					Very dense.
55							Total Depth = 51.5 feet. Groundwater was encountered at a depth of approximately 6.0 feet during drilling. Backfilled on 5/10/23. Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
60							

DATE DRILLED 5/10/23 BORING NO. B-11

GROUND ELEVATION 4,214' ± (MSL) SHEET 1 OF 3

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						CL	TOP SOIL: Unit is approximately 2 inches thick. FILL: Light brown, moist, very stiff, lean CLAY.
		6/6" 10/6" 13/6"	16.9	89.2			
		11/6" 7/6" 7/6"				CL	NATIVE SOIL: Dark brown, moist, very stiff, lean CLAY.
5		2/6" 4/6" 6/6"	21.2	93.2		SM	Dark brown, wet, loose, silty SAND.
		2/6" 4/6" 5/6"				CL	Light brown, wet, stiff, lean CLAY.
10							
15		2/6" 4/6" 4/6"	31.3	92.0			
20							

FIGURE A- 23

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1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/10/23 BORING NO. B-11

GROUND ELEVATION 4,214' ± (MSL) SHEET 2 OF 3

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		2/6" 1/6" 3/6"				CL	NATIVE SOIL: (Continued) Gray, wet, firm, lean CLAY.
25		2/6" 4/6" 4/6"	33.0	86.1			Stiff.
30		2/6" 1/6" 3/6"					Firm.
35		3/6" 8/6" 16/6"	22.5	96.4			Very stiff; with sand.
40							

FIGURE A- 24

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 5/10/23 BORING NO. B-11

GROUND ELEVATION 4,214' ± (MSL) SHEET 3 OF 3

METHOD OF DRILLING Marl M5 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40		3/6" 3/6" 3/6"				CL	NATIVE SOIL: (Continued) Gray, wet, stiff, lean CLAY with sand.
45		8/6" 12/6" 22/6"	25.0	97.0			Hard.
50		3/6" 6/6" 5/6"				SP	Gray, wet, medium dense, poorly graded SAND.
55							Total Depth = 51.5 feet. Groundwater was encountered at a depth of approximately 13.0 feet during drilling. Backfilled on 5/10/23. Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
60							

DATE DRILLED 6/21/23 BORING NO. B-12

GROUND ELEVATION 4,214' ± (MSL) SHEET 1 OF 4

METHOD OF DRILLING Driedrich D-50 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SC	FILL: Light brown, dry, loose, clayey SAND with gravel.
		7/6" 7/6" 3/6"					Moist; medium dense.
						CL	Brown, wet, stiff, lean CLAY; few to little sand.
		7/6" 6/6" 9/6"					Very stiff.
5						CL	NATIVE SOIL: Gray, wet, very stiff, lean CLAY.
		2/6" 2/6" 4/6"	15.9	80.8			Brown; stiff; with sand.
		3/6" 5/6" 9/6"	27.0	92.0			Very stiff.
10							Wet
15		2/6" 2/6" 4/6"					Stiff; few sand.
20							

FIGURE A- 26

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GROUND ELEVATION 4,214' ± (MSL) SHEET 2 OF 4

METHOD OF DRILLING Driedrich D-50 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		2/6" 4/6" 4/6"	26.4	94.0		CH	NATIVE SOIL: (Continued) Grayish blue, wet, stiff, fat CLAY.
25		3/6" 3/6" 3/6"				CL	Grayish blue, wet, stiff, lean CLAY with sand.
30		2/6" 2/6" 4/6"	33.6	86.2		CH	Grayish black, wet, firm, fat CLAY; trace sand.
35		2/6" 8/6" 5/6"					Very stiff.
						SP	Gray, wet, medium dense, poorly graded SAND.
40							

FIGURE A- 27

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1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

DATE DRILLED 6/21/23 BORING NO. B-12

GROUND ELEVATION 4,214' ± (MSL) SHEET 3 OF 4

METHOD OF DRILLING Driedrich D-50 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40		5/6" 4/6" 8/6"	27.7	94.5		CH	NATIVE SOIL: (Continued) Gray, wet, stiff, fat CLAY.
45		6/6" 5/6" 10/6"				SP	Gray, wet, medium dense, poorly graded SAND.
50		6/6" 8/6" 10/6"	25.3	66.7		CH	Grayish blue, wet, very stiff, fat CLAY.
55		4/6" 4/6" 8/6"					Total Depth = 56.5 feet. Groundwater was encountered at a depth of approximately 10.5 feet during drilling. Groundwater was measured at a depth of 2.3 feet approximately 48 hours after drilling. Backfilled on 6/23/23 Notes: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations
60							

DATE DRILLED 6/21/23 BORING NO. B-12

GROUND ELEVATION 4,214' ± (MSL) SHEET 4 OF 4

METHOD OF DRILLING Driedrich D-50 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY EAS LOGGED BY EAS REVIEWED BY REG/EDE

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
60								of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
65								
70								
75								
80								

APPENDIX B

Laboratory Test Results

APPENDIX B

LABORATORY TEST RESULTS

Classification
Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-Place Moisture and Density
The moisture content and dry density of relatively undisturbed samples obtained from the exploratory excavations were evaluated in general accordance with ASTM D2937. The test results are presented on the logs of the exploratory excavations in Appendix A.

Gradation Analysis
Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D7928, C136 and C117. These test results were utilized in evaluating the soil classifications in accordance with the USCS. The grain-size distribution curves are shown on Figure B-1 through Figure B-8.

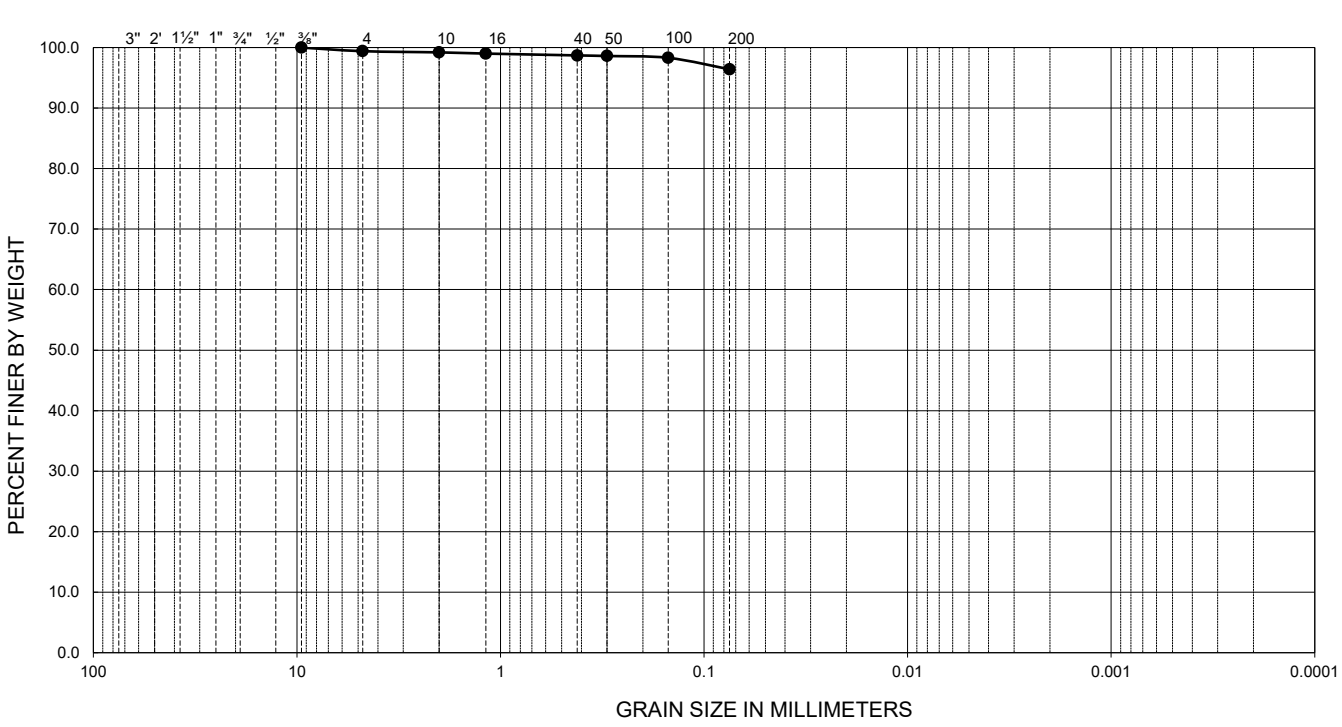
Atterberg Limits
Tests were performed on selected representative soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D4318. These test results were utilized to evaluate soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-9.

Consolidation
Consolidation tests were performed on selected relatively undisturbed soil samples in general accordance with ASTM D2435. The samples were inundated during testing to represent adverse field conditions. The percent of consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. The consolidation test results are summarized graphically on Figure B-10 through Figure B-17.

Direct Shear
Direct shear tests were performed on undisturbed samples in general accordance with ASTM D3080 to evaluate the shear strength characteristics of selected materials. The samples were inundated during shearing to represent adverse field conditions. The results are shown on Figure B-18 and Figure B-19.

Unconsolidated Undrained Triaxial Compression
Unconfined undrained compression tests were performed on undisturbed samples in general accordance with ASTM D2850. The test results are shown on Figures B-20 through B-23.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-4	15.0-20.0	37	16	21	--	--	--	--	--	96.4	CL

Material Percent by Weight		
Gravel	Sand	Fines
0.6	3.0	96.4

Soil Type
Lean CLAY

Moisture Content
38.3%

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D422

FIGURE B-1

GRADATION TEST RESULTS

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1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

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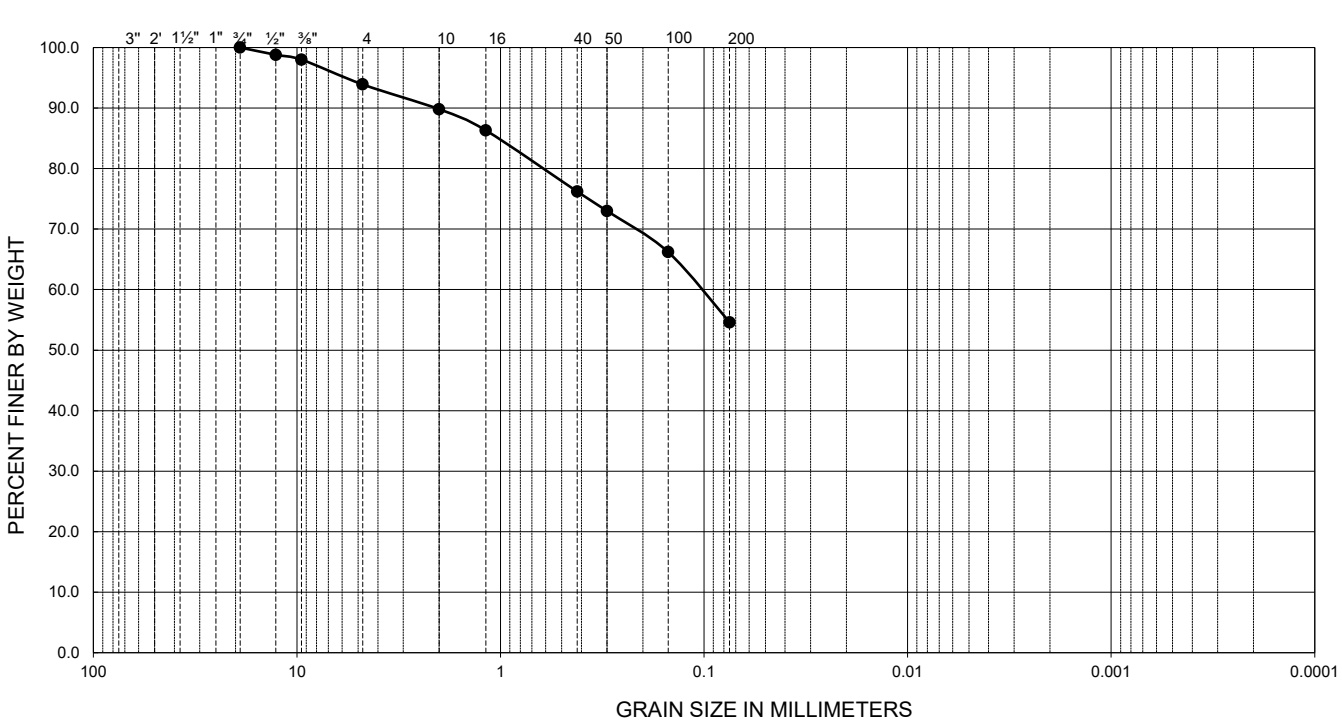
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-5	6.0-10.0	38	16	22	--	--	0.10	--	--	54.6	CL

Material Percent by Weight		
Gravel	Sand	Fines
6.1	39.3	54.6

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D422

Soil Type
Sandy lean CLAY
Moisture Content
33.5%

FIGURE B-2

GRADATION TEST RESULTS

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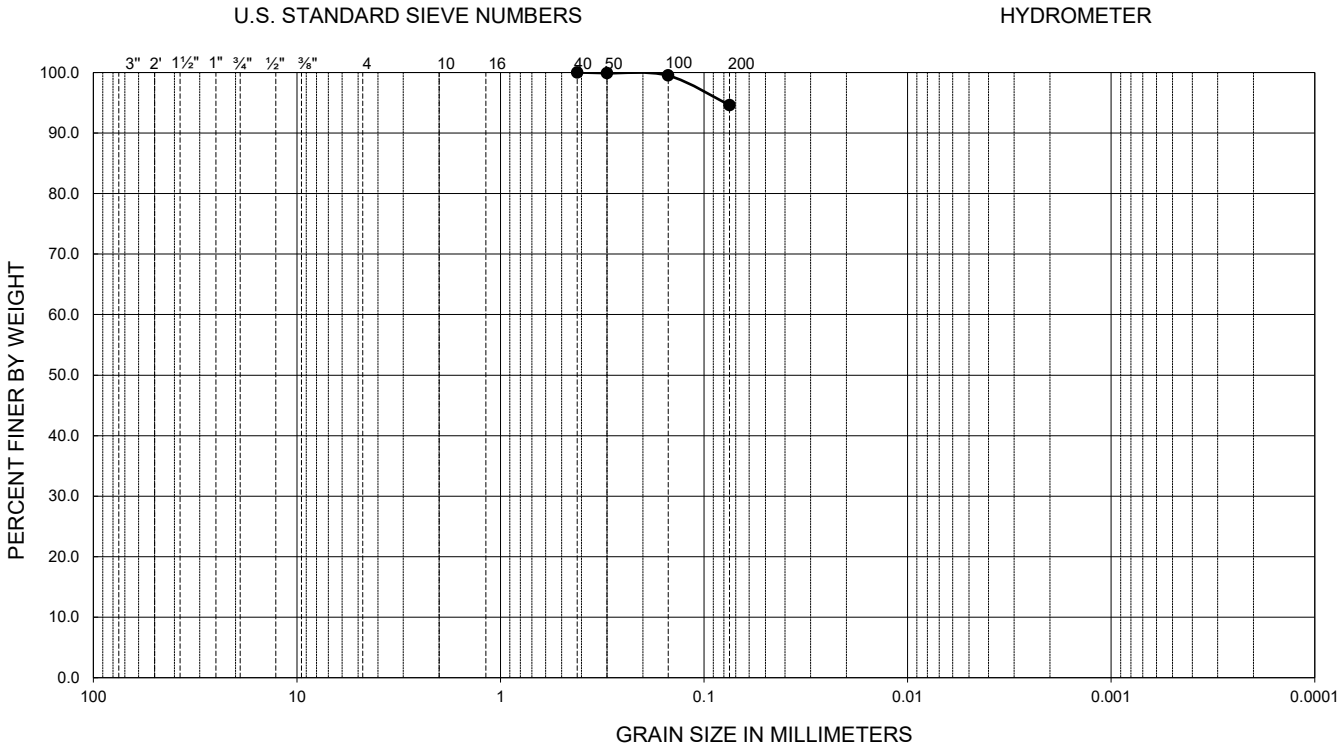
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-5	30.0-31.5	38	15	23	--	--	--	--	--	94.6	CL

Material Percent by Weight		
Gravel	Sand	Fines
0.0	5.4	94.6

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D422

Soil Type
Lean CLAY
Moisture Content
25.5%

FIGURE B-3

GRADATION TEST RESULTS

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
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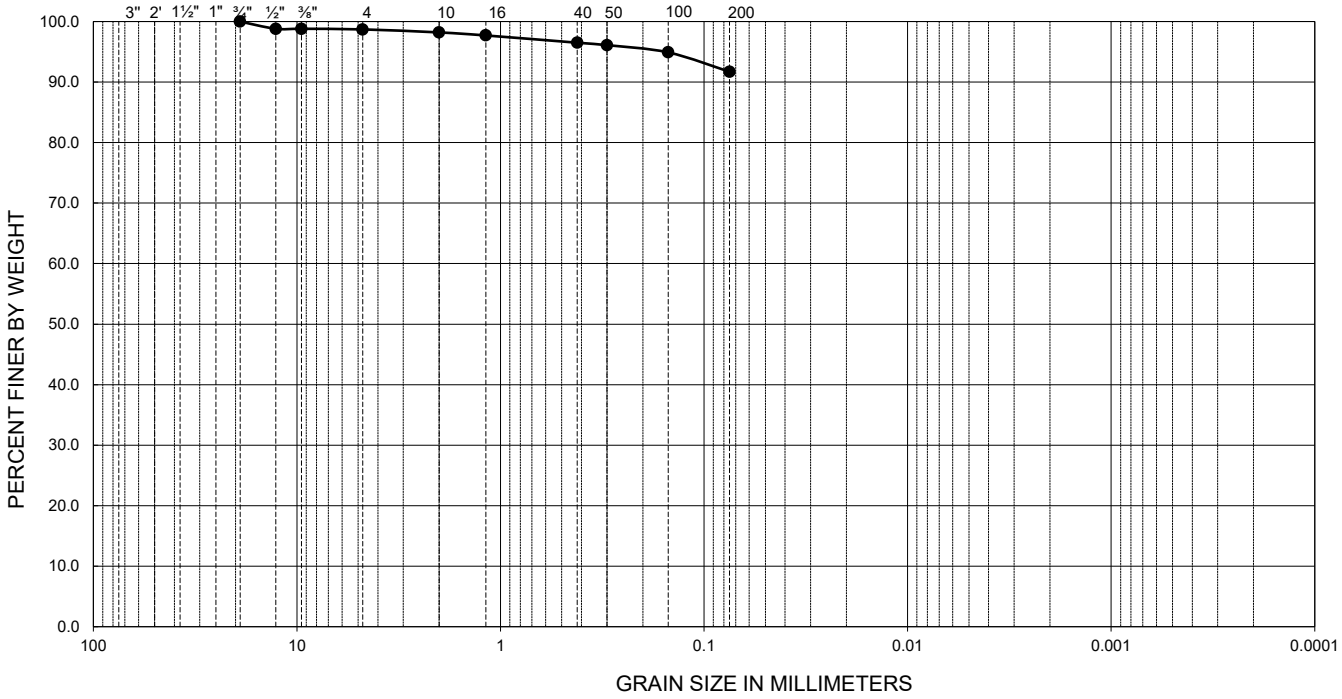
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

U.S. STANDARD SIEVE NUMBERS

HYDROMETER



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-6	11.0-15.0	39	15	24	--	--	--	--	--	91.7	CL

Material Percent by Weight			Soil Type
Gravel	Sand	Fines	Lean CLAY
1.3	7.0	91.7	
			Moisture Content
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D422			30.9%

FIGURE B-4

GRADATION TEST RESULTS

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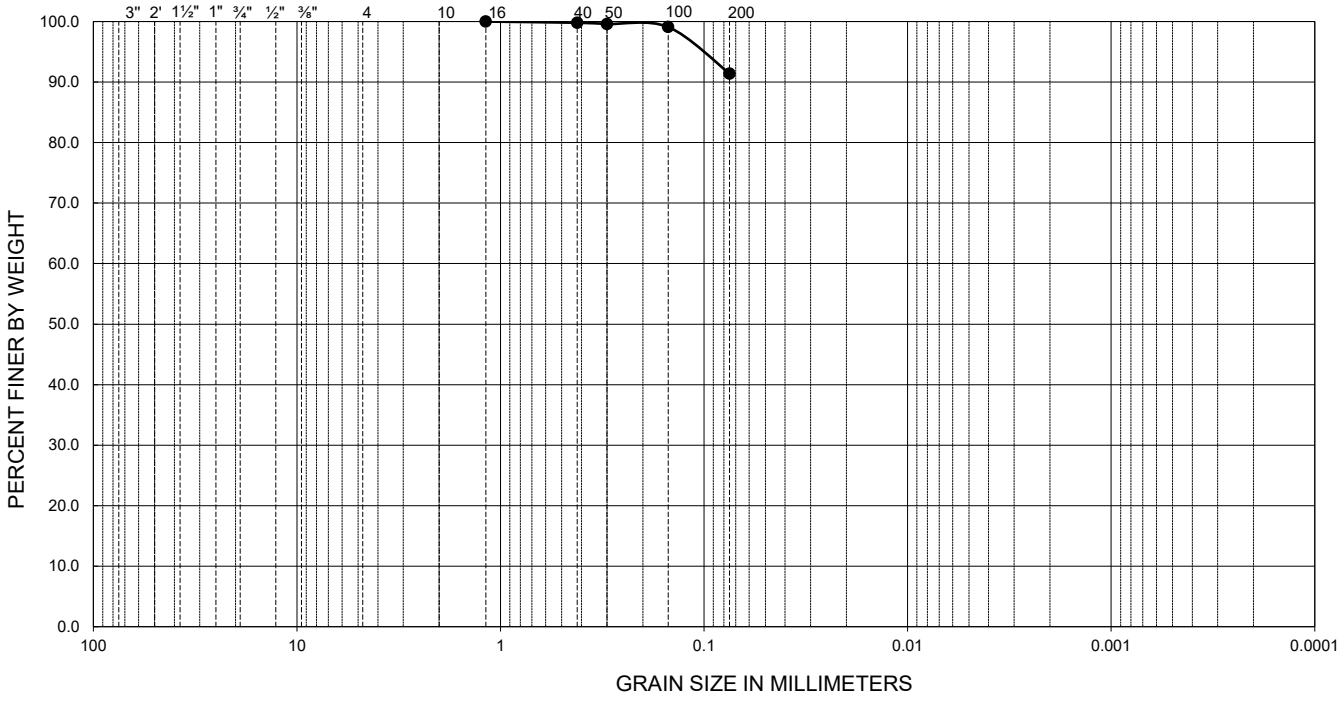
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

U.S. STANDARD SIEVE NUMBERS HYDROMETER



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-8	30.0-31.5	32	15	17	--	--	--	--	--	91.4	CL

Material Percent by Weight		
Gravel	Sand	Fines
0.0	8.6	91.4

Soil Type
Lean CLAY

Moisture Content
29.0%

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D422

FIGURE B-5

GRADATION TEST RESULTS

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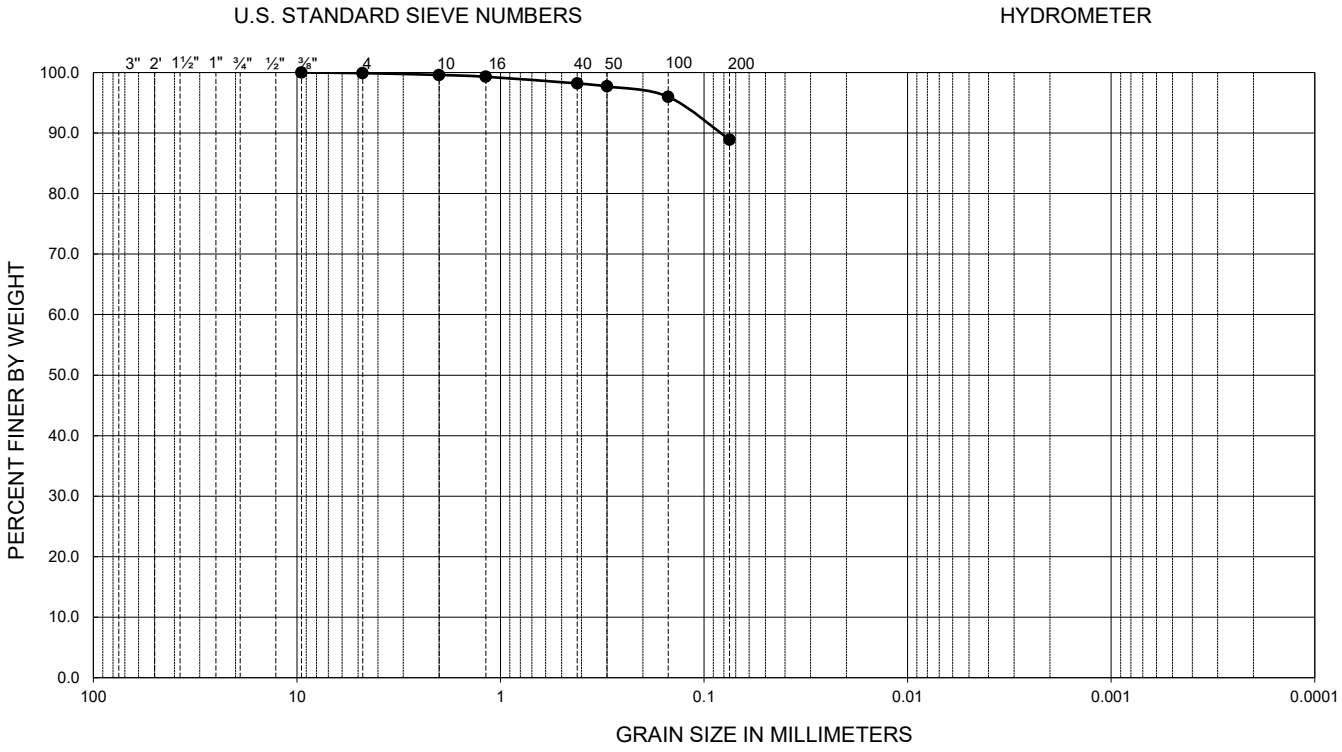
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-9	8.5-12.0	31	15	16	--	--	--	--	--	88.9	CL

Material Percent by Weight			Soil Type
Gravel	Sand	Fines	Lean CLAY
0.1	11.0	88.9	
			Moisture Content
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D422			40.9%

FIGURE B-6

GRADATION TEST RESULTS

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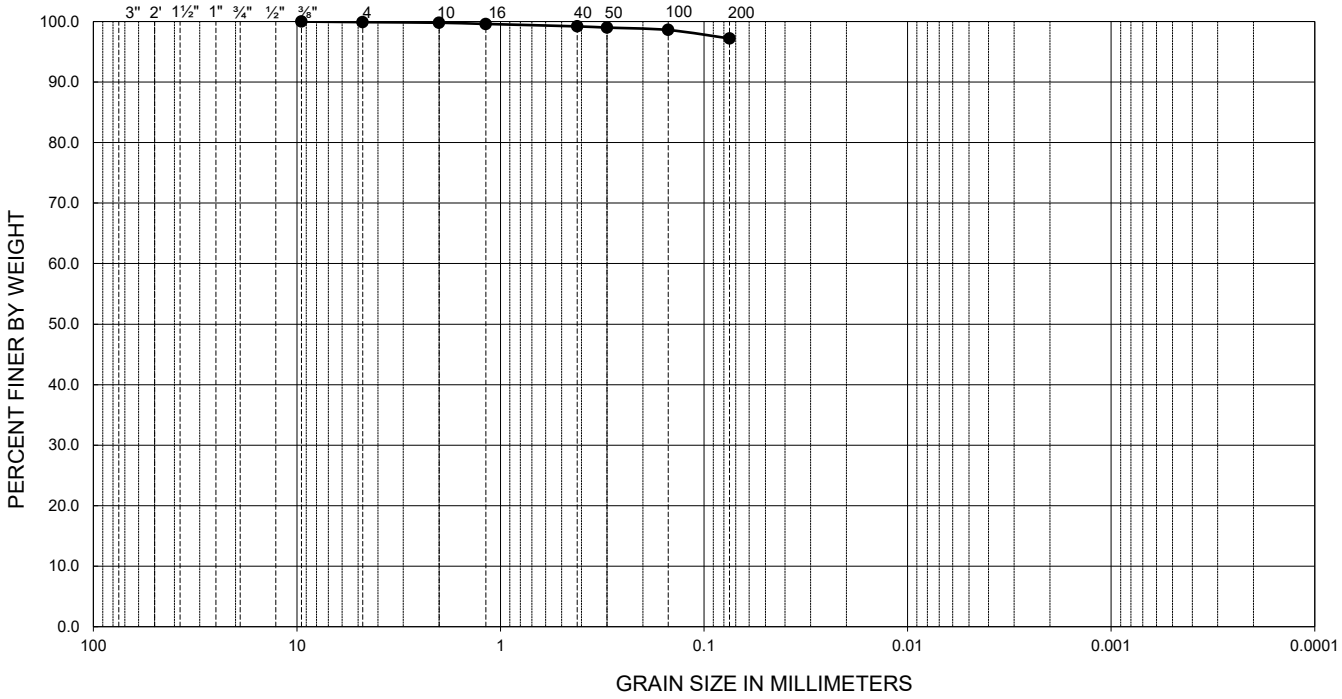
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

U.S. STANDARD SIEVE NUMBERS

HYDROMETER



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-10	15.0-20.0	37	17	20	--	--	--	--	--	97.2	CL

Material Percent by Weight		
Gravel	Sand	Fines
0.1	2.7	97.2

Soil Type
Lean CLAY

Moisture Content
33.0%

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D422

FIGURE B-7

GRADATION TEST RESULTS

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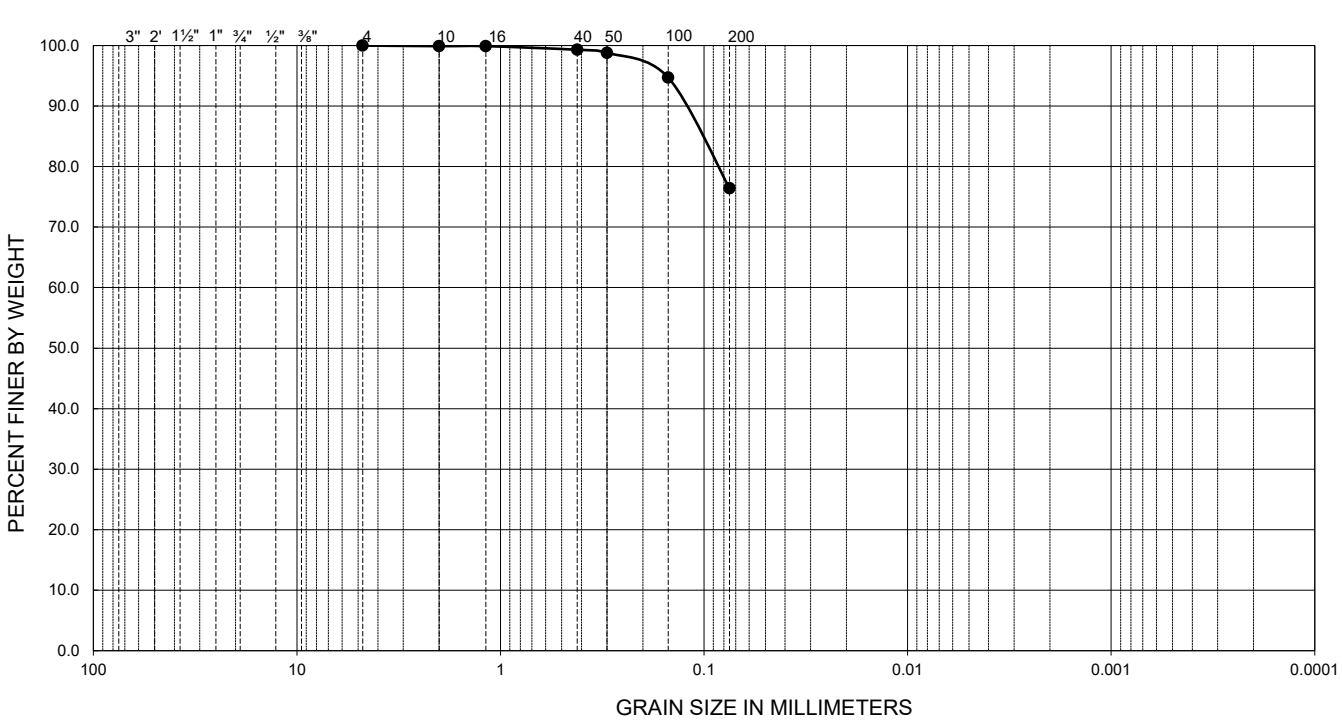
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-11	35.0-36.5	34	16	18	--	--	--	--	--	76.4	CL

Material Percent by Weight			Soil Type
Gravel	Sand	Fines	Lean CLAY with sand
0.0	23.6	76.4	
			Moisture Content
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D422			22.5%

FIGURE B-8

GRADATION TEST RESULTS

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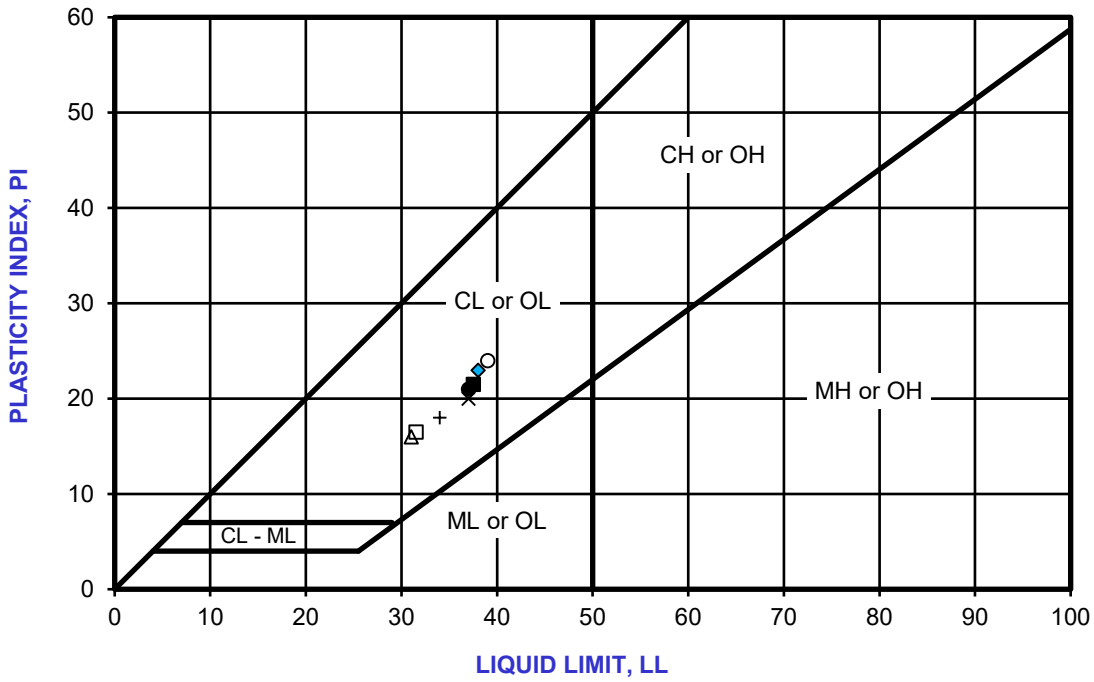
SYMBOL	LOCATION	DEPTH (ft)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS
●	B-4	15.0 - 20.0	37	16	21	CL	CL
■	B-5	6.0 - 10.0	38	16	22	CL	CL
◆	B-5	30.0 - 31.5	38	15	23	CL	CL
○	B-6	11.0 - 15.0	39	15	24	CL	CL
□	B-8	30.0 - 31.5	32	15	17	CL	CL
△	B-9	8.5 - 12.0	31	15	16	CL	CL
X	B-10	15.0 - 20.0	37	17	20	CL	CL
+	B-11	35.0 - 36.5	34	16	18	CL	CL



PERFORMED IN GENERAL ACCORDANCE WITH D4318

FIGURE B-9

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ATTERBERG LIMITS TEST RESULTS

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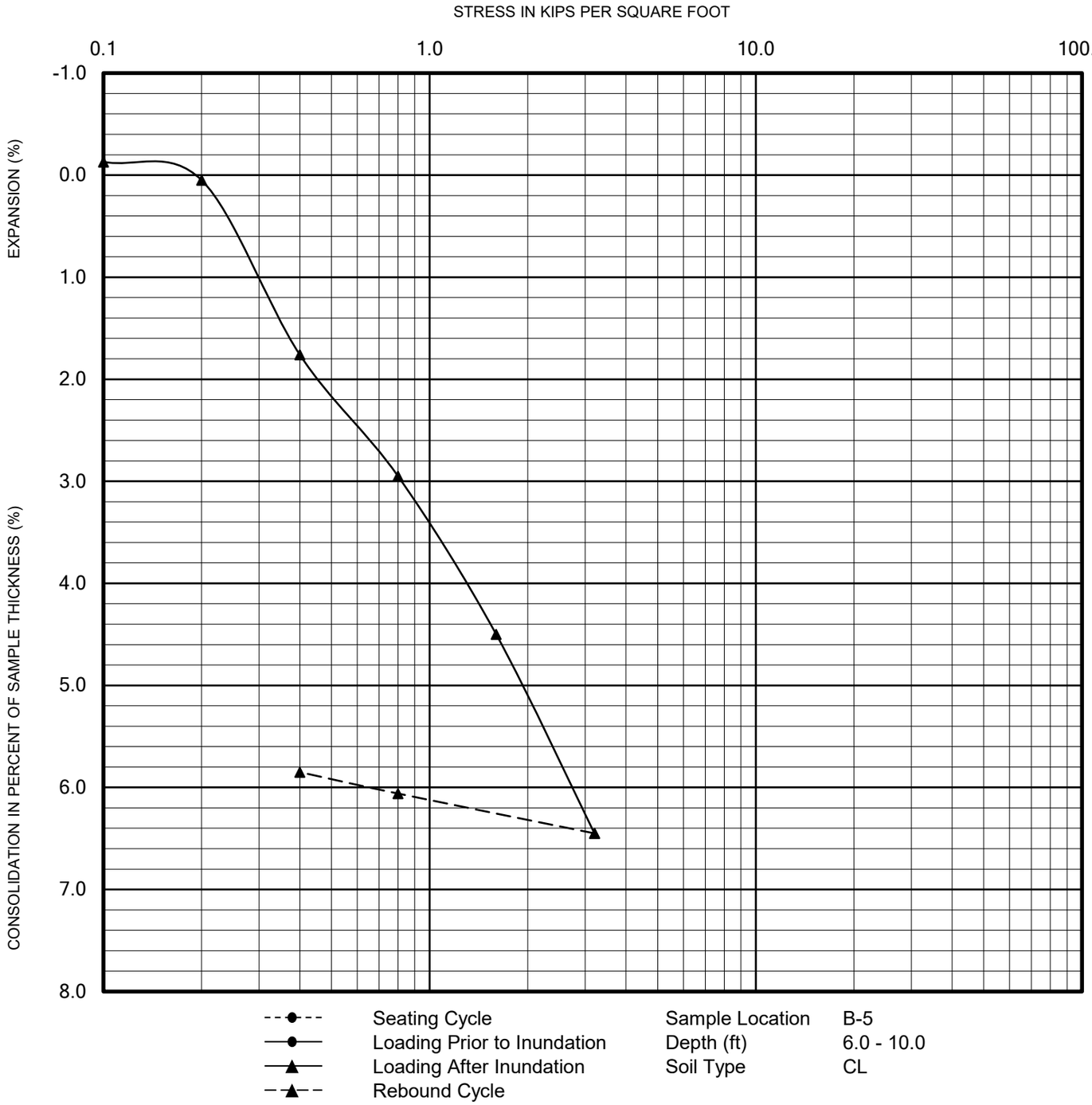

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D2435

FIGURE B-10

CONSOLIDATION TEST RESULTS

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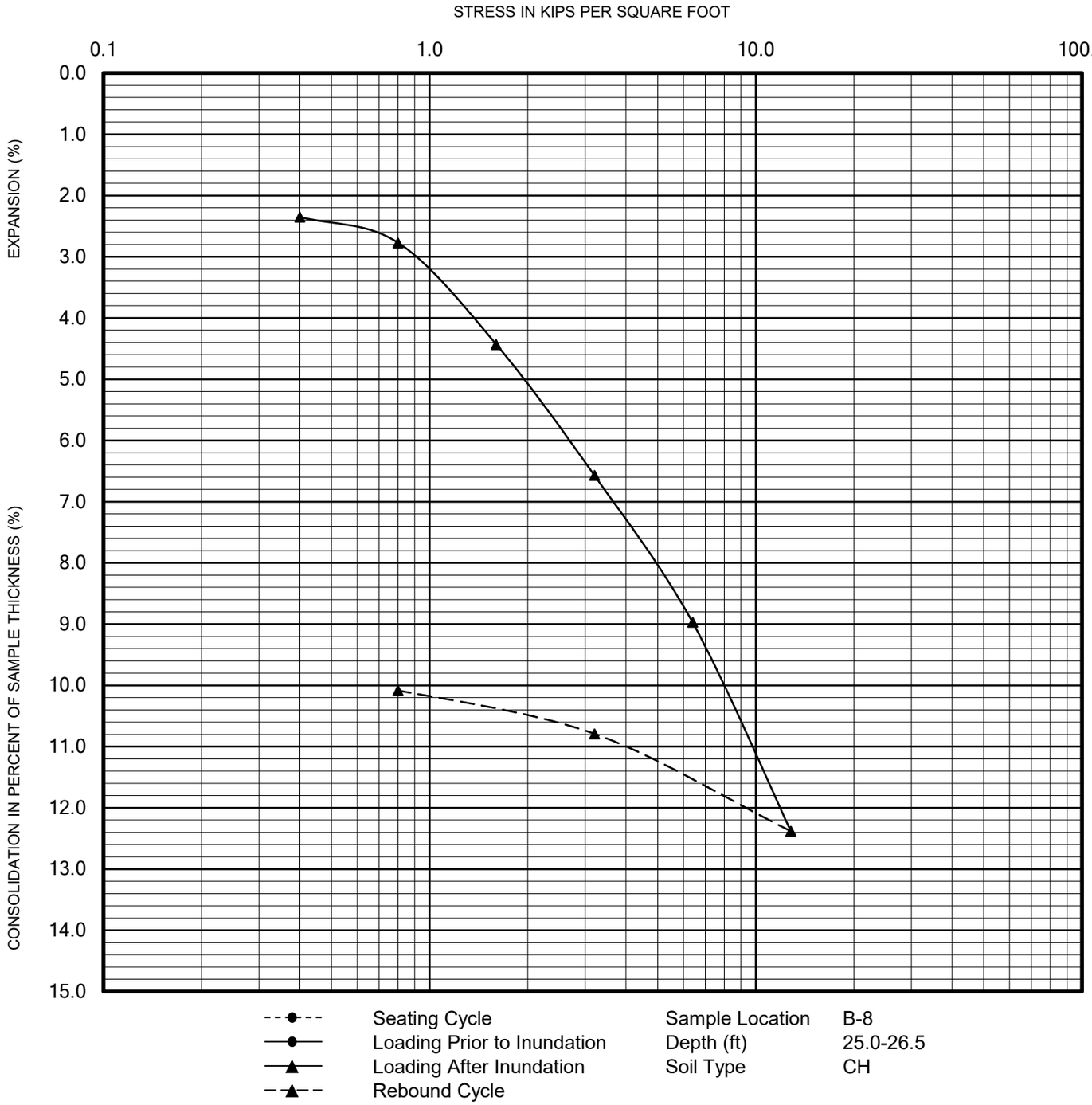

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D2435

FIGURE B-11

CONSOLIDATION TEST RESULTS

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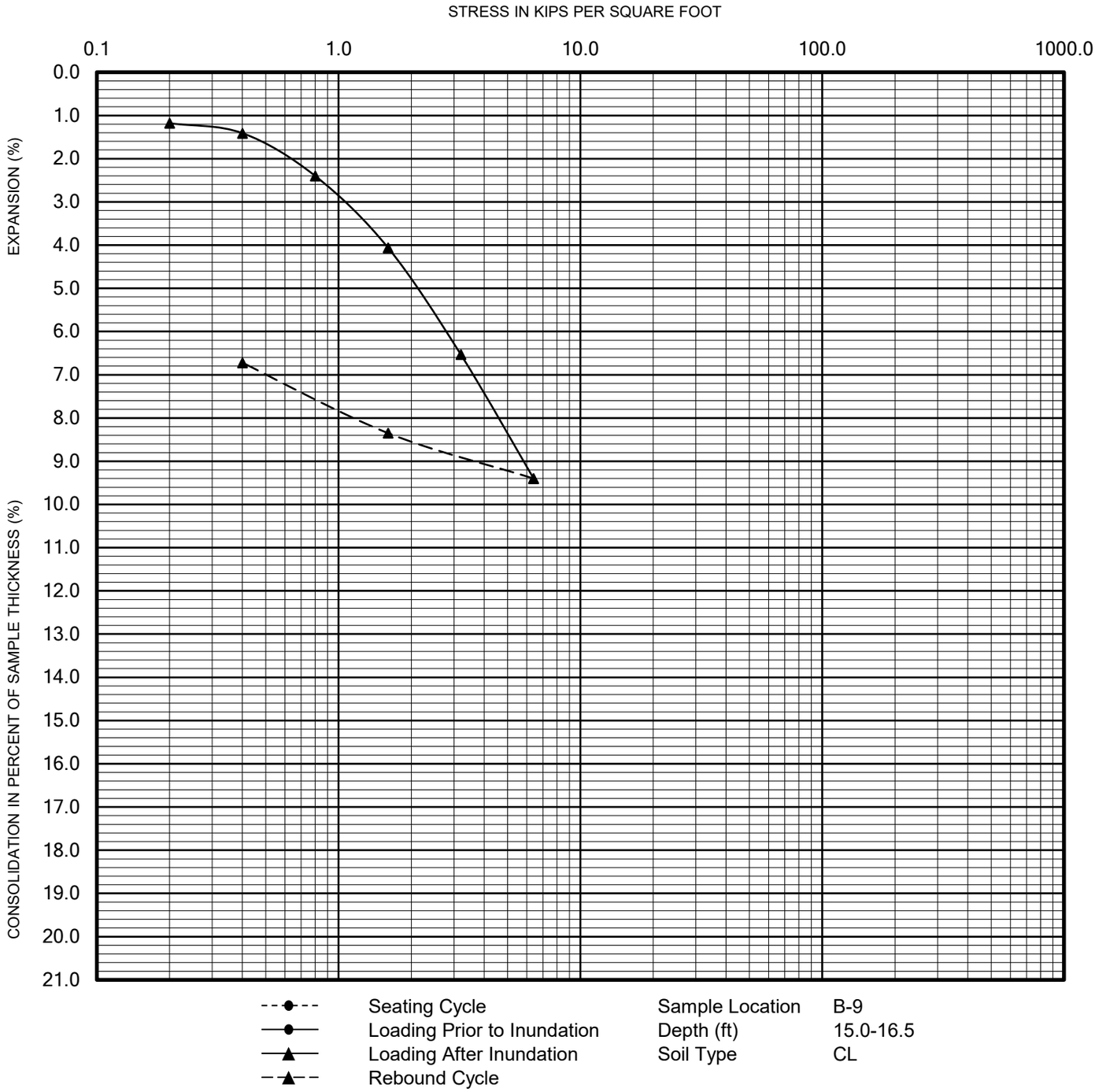

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D2435

FIGURE B-12

CONSOLIDATION TEST RESULTS

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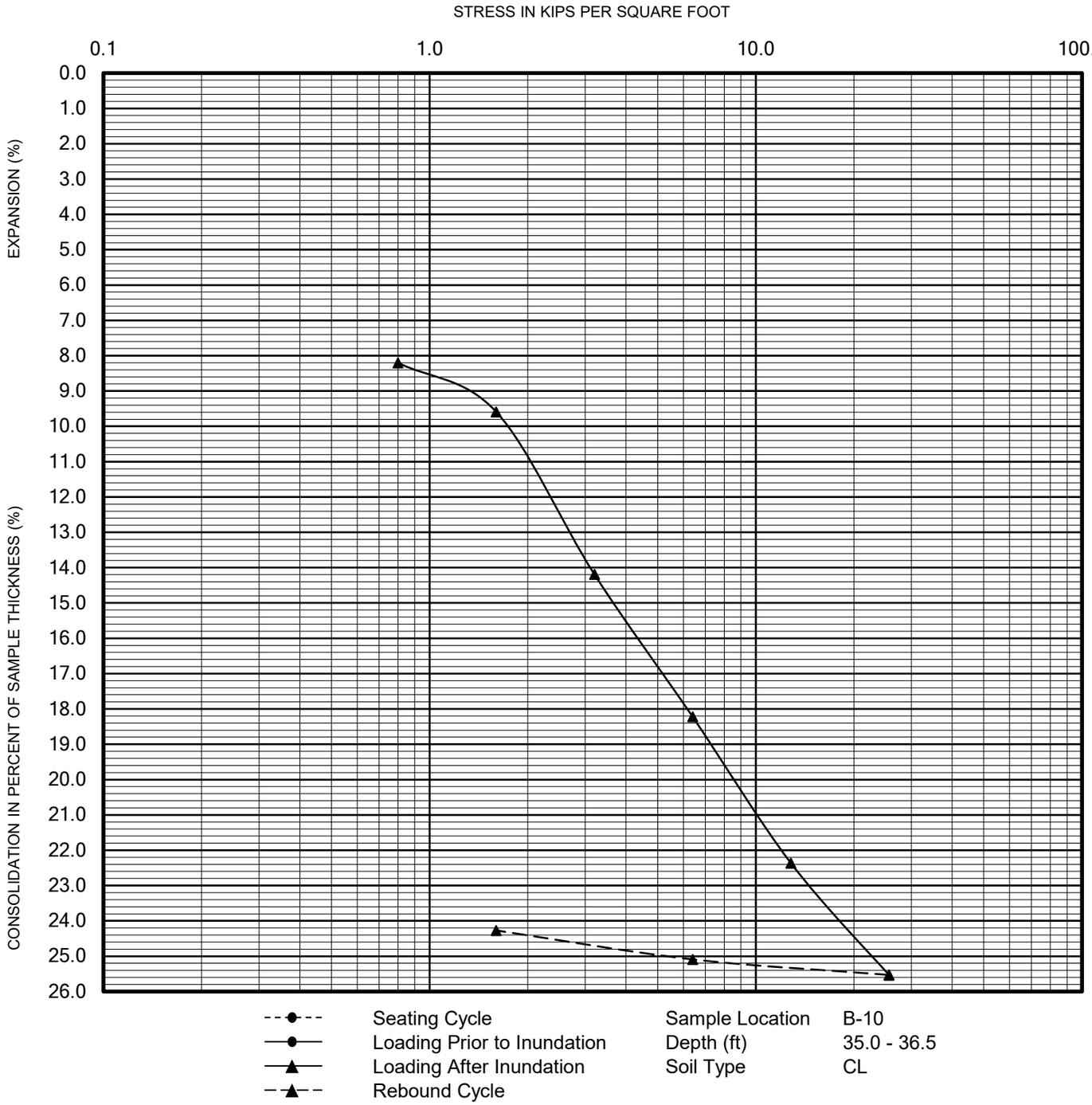

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D2435

FIGURE B-13

CONSOLIDATION TEST RESULTS

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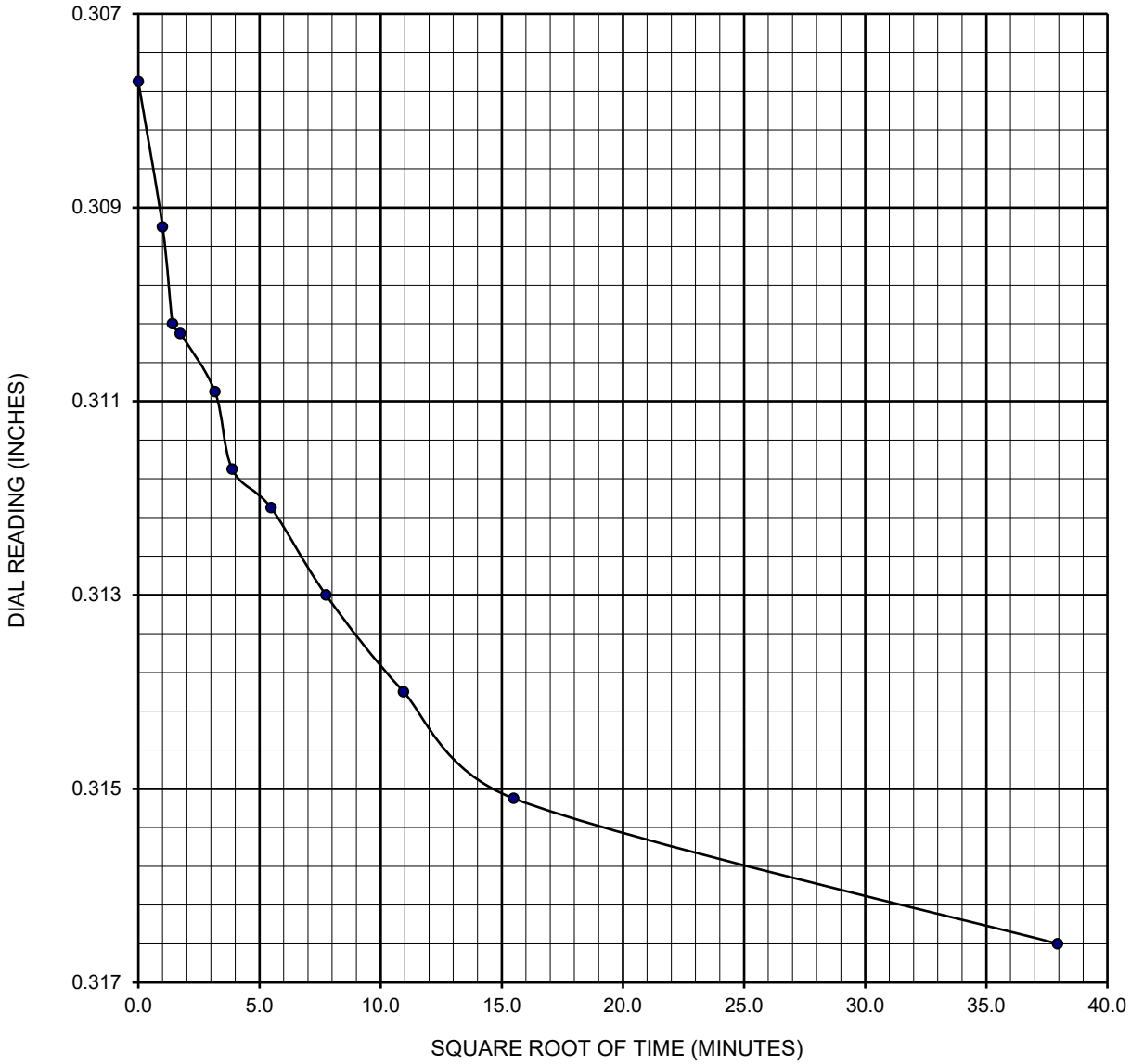

Sample Location	B-5	Load (ksf)	1.6
Depth (ft)	6.0 - 10.0	Soil Type	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D2435 - SQUARE ROOT OF TIME METHOD

FIGURE B-14

TIME RATE OF CONSOLIDTION TEST RESULTS

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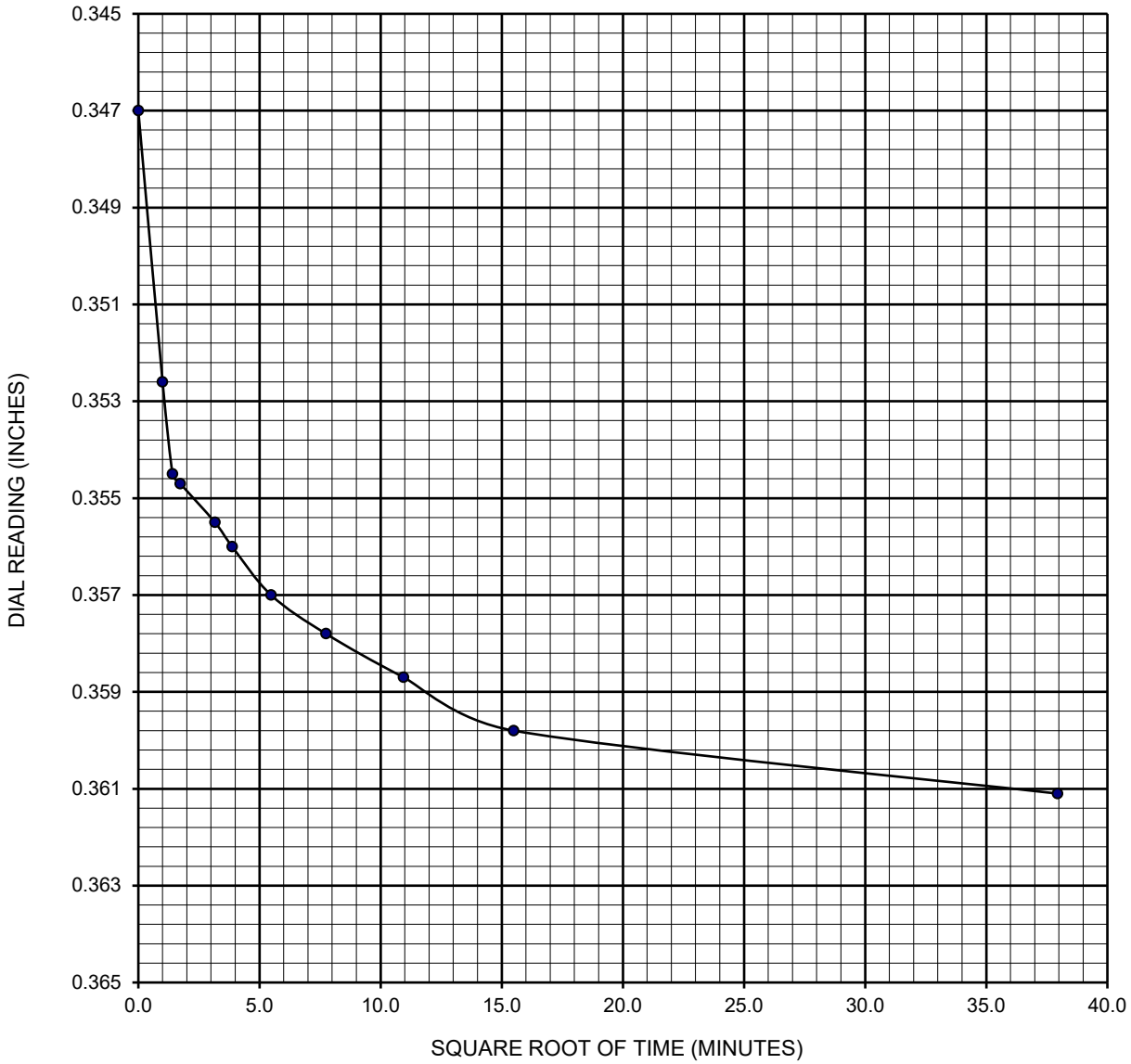

Sample Location	B-8	Load (ksf)	6.4
Depth (ft)	25.0 - 26.5	Soil Type	CH

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D2435 - SQUARE ROOT OF TIME METHOD

FIGURE B-15

TIME RATE OF CONSOLIDTION TEST RESULTS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

800272001 | 7/23

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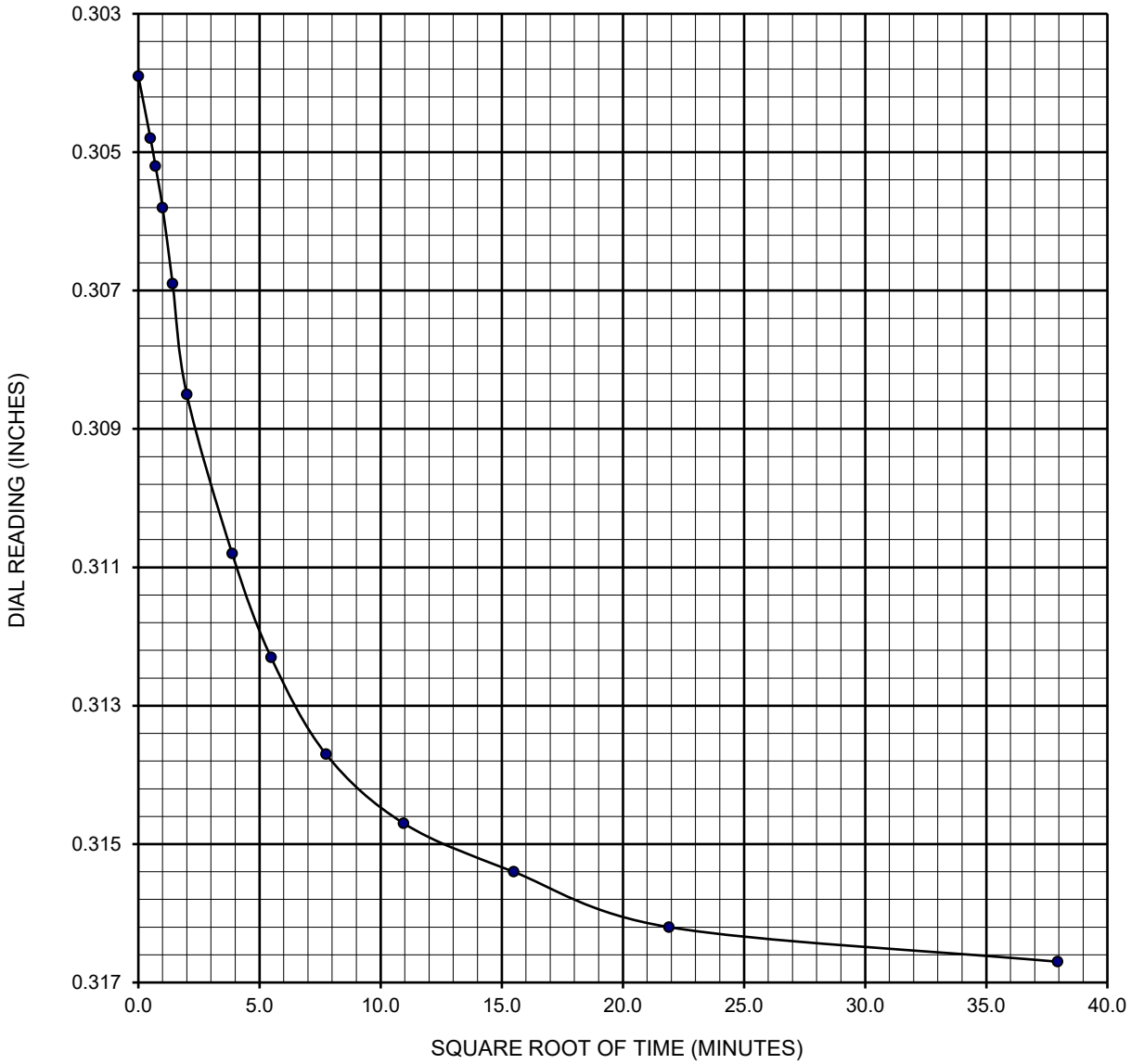

Sample Location	B-9	Load (ksf)	1.6
Depth (ft)	15.0 - 16.5	Soil Type	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D2435 - SQUARE ROOT OF TIME METHOD

FIGURE B-16

TIME RATE OF CONSOLIDTION TEST RESULTS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

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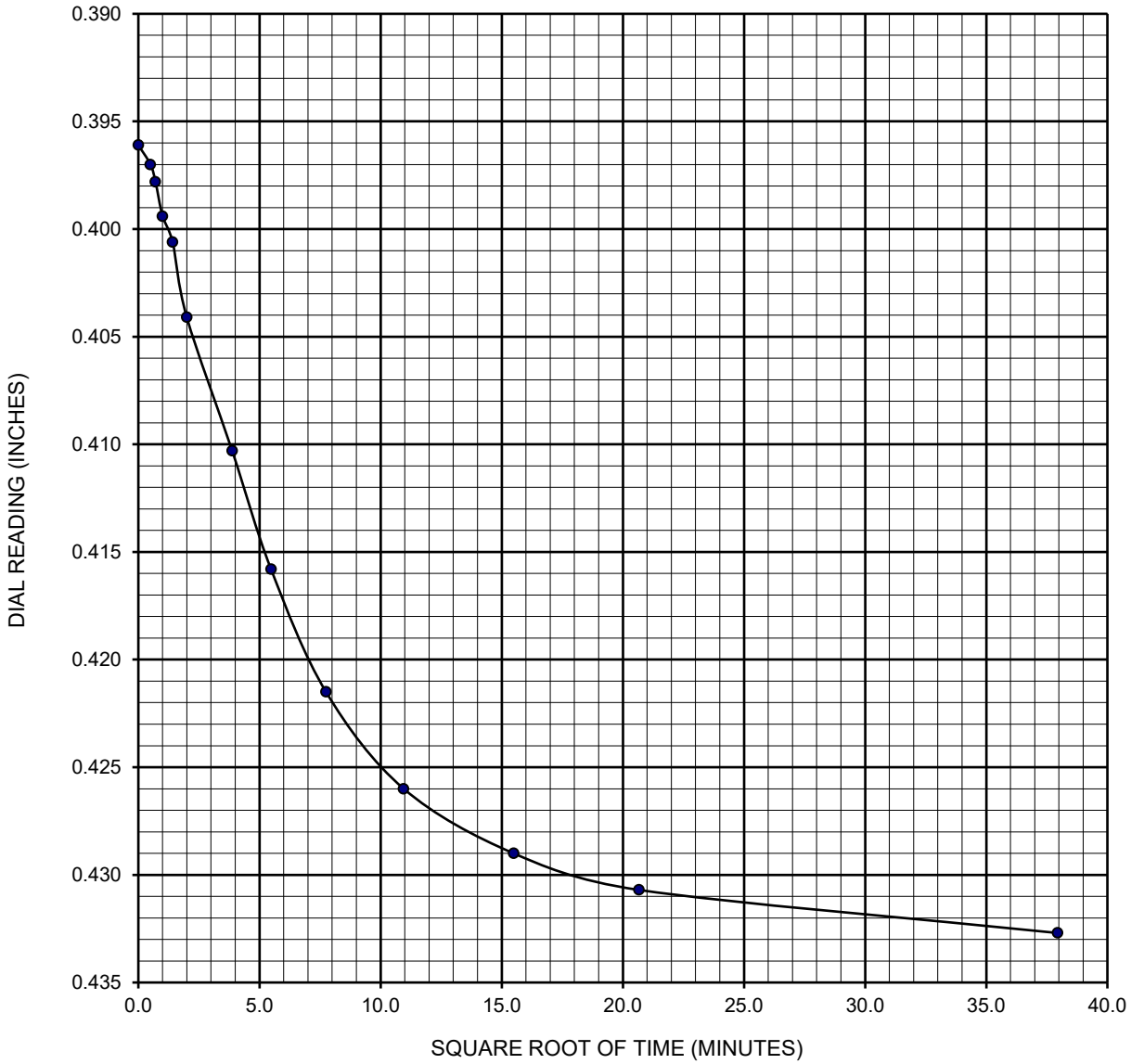

Sample Location	B-10	Load (ksf)	6.4
Depth (ft)	35.0 - 36.5	Soil Type	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D2435 - SQUARE ROOT OF TIME METHOD

FIGURE B-17

TIME RATE OF CONSOLIDTION TEST RESULTS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

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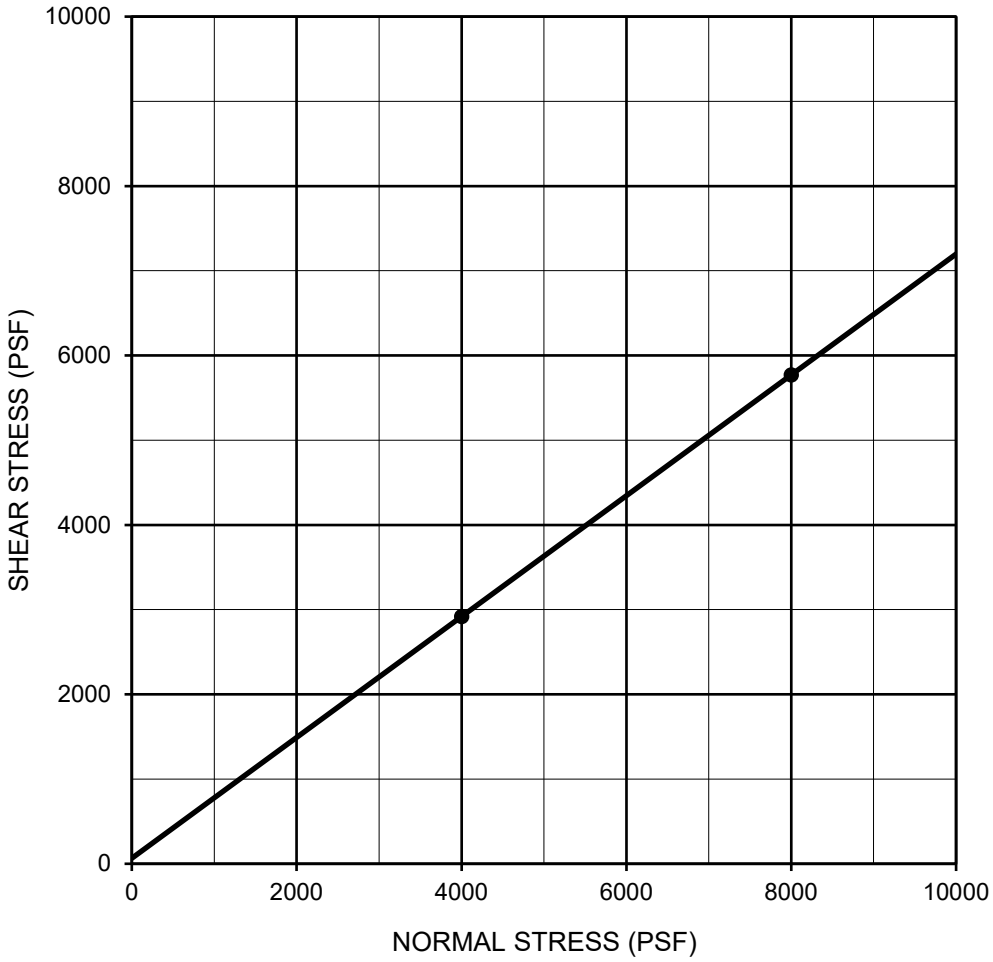

Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
Lean CLAY	—●—	B-4	35.0-36.5	Peak	65	36	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D3080

FIGURE B-18

DIRECT SHEAR TEST RESULTS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

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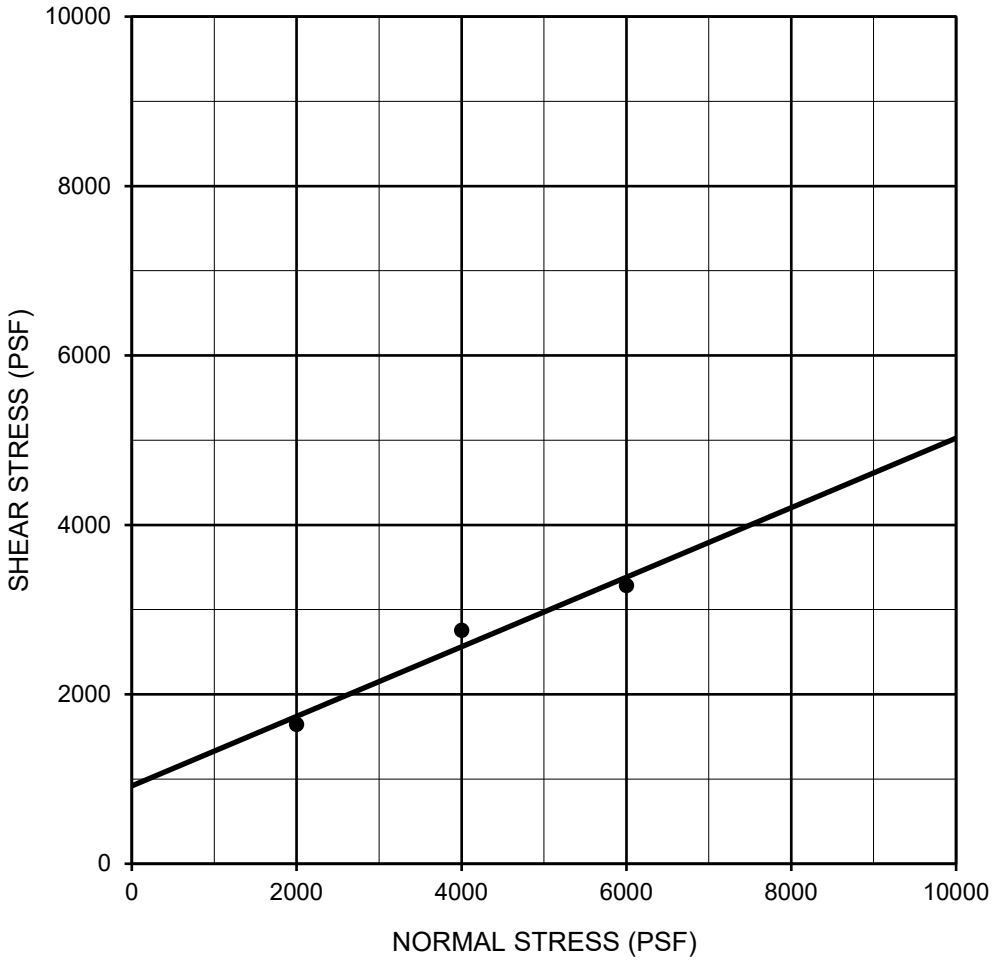

Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
Lean CLAY	—●—	B-11	15.0-16.5	Peak	919	22	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D3080

FIGURE B-19

DIRECT SHEAR TEST RESULTS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

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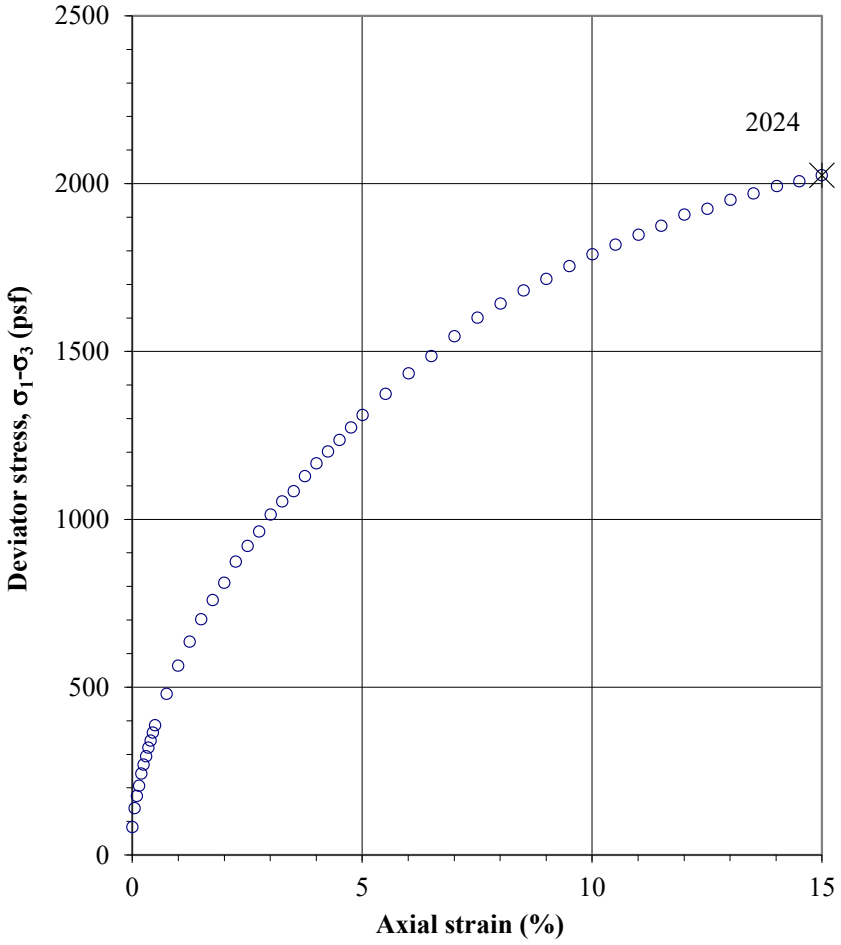
Specific gravity, Gs	2.70	Assumed
Sample height, H (in.)	4.976	
Sample diameter, D (in.)	2.410	
Sample volume, V (ft^3)	0.0131	
Wt. rings + wet soil (g)	731.74	
Wt. rings/tare (g)	0.00	
Moist soil, Ws (g)	731.74	
Moist unit wt., γ_m (pcf)	122.8	
Dry unit wt., γ_d (pcf)	**94.1**	
Saturation (%)	100.0	
Void ratio, *e*	0.80	

Wet soil + tare (g)	235.12
Dry soil + tare (g)	209.91
Tare (g)	127.46
Water content, w (%)	**30.6**
Confining stress, σ_3 (psf)	2813
Shear rate (in/min)	0.0149
Strain at failure, ε_f (%)	15.00
Deviator stress at failure, $(\sigma_1-\sigma_3)_f$ (psf)	2024
Shear stress at failure, $q_f = (\sigma_1-\sigma_3)_f/2$ (psf)	1012

Axial Strain	σ_d $\sigma_1-\sigma_3$	Q 1/2 σ_d
0.00	82.1	41.0
0.05	138.3	69.2
0.10	174.8	87.4
0.15	204.8	102.4
0.20	241.5	120.8
0.25	268.4	134.2
0.30	292.6	146.3
0.35	319.1	159.6
0.40	339.8	169.9
0.45	363.4	181.7
0.50	385.6	192.8
0.75	479.3	239.6
1.00	562.5	281.2
1.25	634.1	317.0
1.50	700.8	350.4
1.75	758.1	379.0
2.00	809.5	404.8
2.25	872.5	436.3
2.51	919.9	460.0
2.76	962.7	481.3
3.01	1012.7	506.3
3.26	1052.5	526.3
3.51	1082.7	541.4
3.76	1127.4	563.7
4.01	1166.1	583.0
4.26	1200.8	600.4
4.51	1235.4	617.7
4.76	1272.9	636.5
5.01	1309.4	654.7
5.51	1372.3	686.2
6.01	1434.0	717.0
6.51	1485.3	742.6
7.01	1544.3	772.2
7.51	1599.4	799.7
8.01	1641.4	820.7
8.51	1681.2	840.6
9.01	1715.2	857.6
9.51	1752.8	876.4
10.01	1788.3	894.2
10.51	1817.6	908.8
11.01	1846.4	923.2
11.51	1873.6	936.8
12.01	1906.4	953.2
12.51	1924.0	962.0
13.01	1950.8	975.4
13.51	1970.1	985.1
14.02	1991.3	995.6
14.51	2006.4	1003.2
15.00	2024.3	1012.1



Sample Location	B-4
Depth (ft)	25.0-26.5
Soil Type	CL

FIGURE B-20

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

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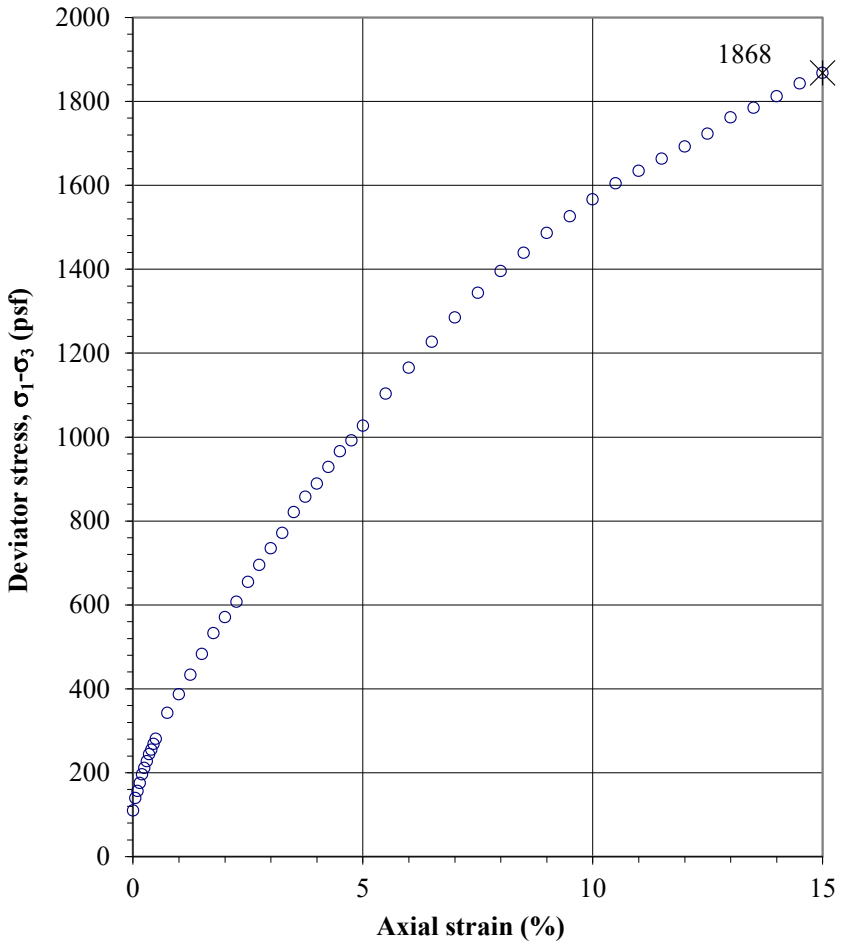
SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

Specific gravity, Gs	2.70	Assumed
Sample height, H (in.)	4.930	
Sample diameter, D (in.)	2.406	
Sample volume, V (ft^3)	0.0130	
Wt. rings + wet soil (g)	697.94	
Wt. rings/tare (g)	0.00	
Moist soil, Ws (g)	697.94	
Moist unit wt., γ_m (pcf)	118.6	
Dry unit wt., γ_d (pcf)	**90.4**	
Saturation (%)	97.1	
Void ratio, *e*	0.87	

Wet soil + tare (g)	813.48
Dry soil + tare (g)	648.90
Tare (g)	121.66
Water content, w (%)	**31.2**
Confining stress, σ_3 (psf)	2827
Shear rate (in/min)	0.0148
Strain at failure, ε_f (%)	15.00
Deviator stress at failure, $(\sigma_1-\sigma_3)_f$ (psf)	1868
Shear stress at failure, $q_f = (\sigma_1-\sigma_3)_f/2$ (psf)	934

Axial Strain	σ_d $\sigma_1-\sigma_3$	Q 1/2 σ_d
0.00	109.2	54.6
0.05	138.7	69.4
0.10	155.7	77.8
0.15	175.0	87.5
0.20	195.2	97.6
0.25	210.6	105.3
0.30	226.6	113.3
0.35	243.5	121.8
0.40	254.5	127.3
0.45	268.3	134.2
0.50	280.1	140.0
0.75	341.8	170.9
1.00	386.1	193.0
1.25	433.0	216.5
1.50	482.0	241.0
1.75	532.2	266.1
2.00	570.0	285.0
2.25	606.6	303.3
2.50	653.7	326.9
2.75	694.6	347.3
3.00	734.5	367.3
3.25	770.9	385.5
3.50	820.5	410.3
3.75	857.2	428.6
4.00	888.4	444.2
4.25	928.0	464.0
4.50	965.2	482.6
4.75	991.5	495.8
5.00	1026.2	513.1
5.50	1102.5	551.3
6.00	1164.2	582.1
6.50	1226.4	613.2
7.00	1284.3	642.1
7.50	1343.2	671.6
8.00	1394.6	697.3
8.50	1438.8	719.4
9.00	1485.8	742.9
9.50	1525.4	762.7
10.00	1565.7	782.9
10.50	1604.2	802.1
11.00	1633.4	816.7
11.50	1662.6	831.3
12.00	1691.7	845.8
12.50	1722.4	861.2
13.00	1761.1	880.5
13.50	1784.4	892.2
14.00	1811.8	905.9
14.50	1842.2	921.1
15.00	1867.6	933.8



Sample Location	B-8
Depth (ft)	25.0-26.5
Soil Type	CL

FIGURE B-21

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

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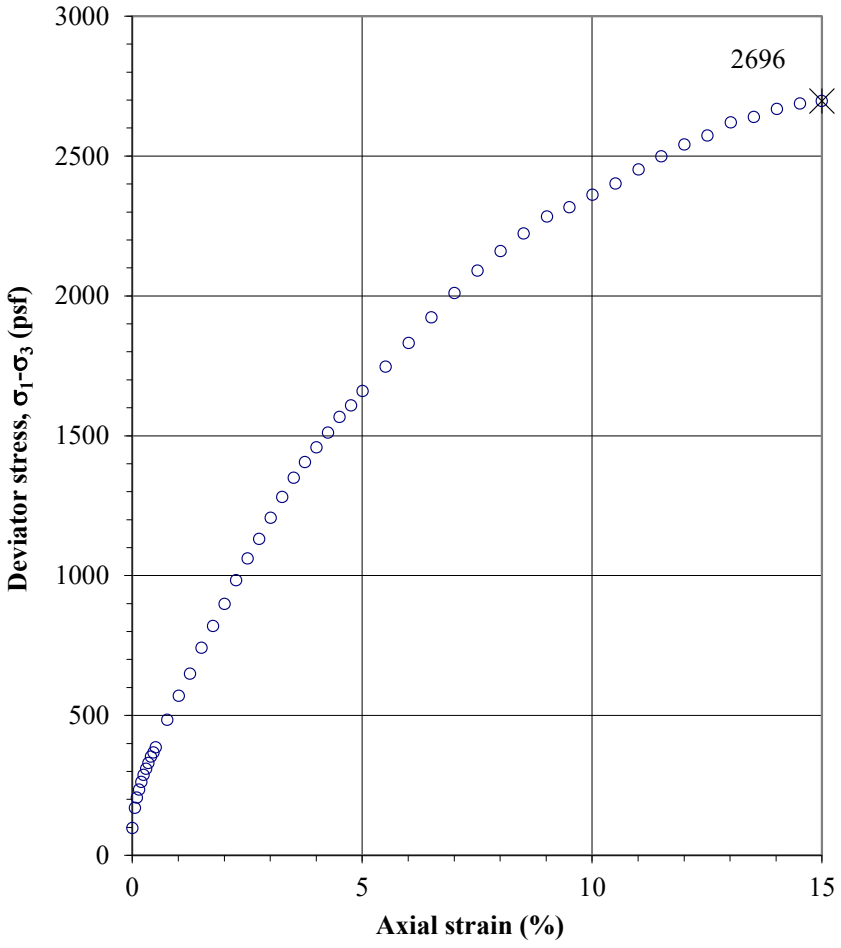
SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

Specific gravity, Gs	2.70	Assumed
Sample height, H (in.)	4.983	
Sample diameter, D (in.)	2.406	
Sample volume, V (ft^3)	0.0131	
Wt. rings + wet soil (g)	719.83	
Wt. rings/tare (g)	0.00	
Moist soil, Ws (g)	719.83	
Moist unit wt., γ_m (pcf)	121.0	
Dry unit wt., γ_d (pcf)	**93.2**	
Saturation (%)	99.5	
Void ratio, *e*	0.81	

Wet soil + tare (g)	278.10
Dry soil + tare (g)	243.51
Tare (g)	127.95
Water content, w (%)	**29.9**
Confining stress, σ_3 (psf)	1723
Shear rate (in/min)	0.0149
Strain at failure, ε_f (%)	15.00
Deviator stress at failure, $(\sigma_1-\sigma_3)_f$ (psf)	2696
Shear stress at failure, $q_f = (\sigma_1-\sigma_3)_f/2$ (psf)	1348

Axial Strain	σ_d $\sigma_1-\sigma_3$	Q 1/2 σ_d
0.00	96.5	48.3
0.06	168.2	84.1
0.10	204.6	102.3
0.15	233.5	116.8
0.20	261.5	130.8
0.25	286.8	143.4
0.30	308.1	154.0
0.35	328.3	164.1
0.41	351.9	175.9
0.46	366.8	183.4
0.51	385.1	192.5
0.76	483.1	241.5
1.01	569.6	284.8
1.26	648.2	324.1
1.51	740.9	370.5
1.76	818.3	409.2
2.01	897.8	448.9
2.26	981.9	490.9
2.51	1060.4	530.2
2.76	1130.2	565.1
3.01	1205.6	602.8
3.26	1279.8	639.9
3.51	1349.0	674.5
3.76	1404.6	702.3
4.01	1457.4	728.7
4.26	1509.6	754.8
4.51	1566.3	783.2
4.76	1607.6	803.8
5.01	1658.5	829.2
5.51	1745.7	872.9
6.01	1829.9	915.0
6.51	1922.0	961.0
7.01	2008.8	1004.4
7.51	2088.7	1044.4
8.01	2159.2	1079.6
8.51	2221.4	1110.7
9.02	2282.1	1141.0
9.51	2315.1	1157.5
10.01	2359.9	1180.0
10.51	2400.2	1200.1
11.01	2450.4	1225.2
11.51	2497.4	1248.7
12.01	2540.3	1270.1
12.51	2572.3	1286.2
13.02	2618.9	1309.5
13.52	2638.5	1319.3
14.02	2667.2	1333.6
14.52	2685.9	1343.0
15.00	2695.9	1348.0



Sample Location	B-9
Depth (ft)	15.0-16.5
Soil Type	CL

FIGURE B-22

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

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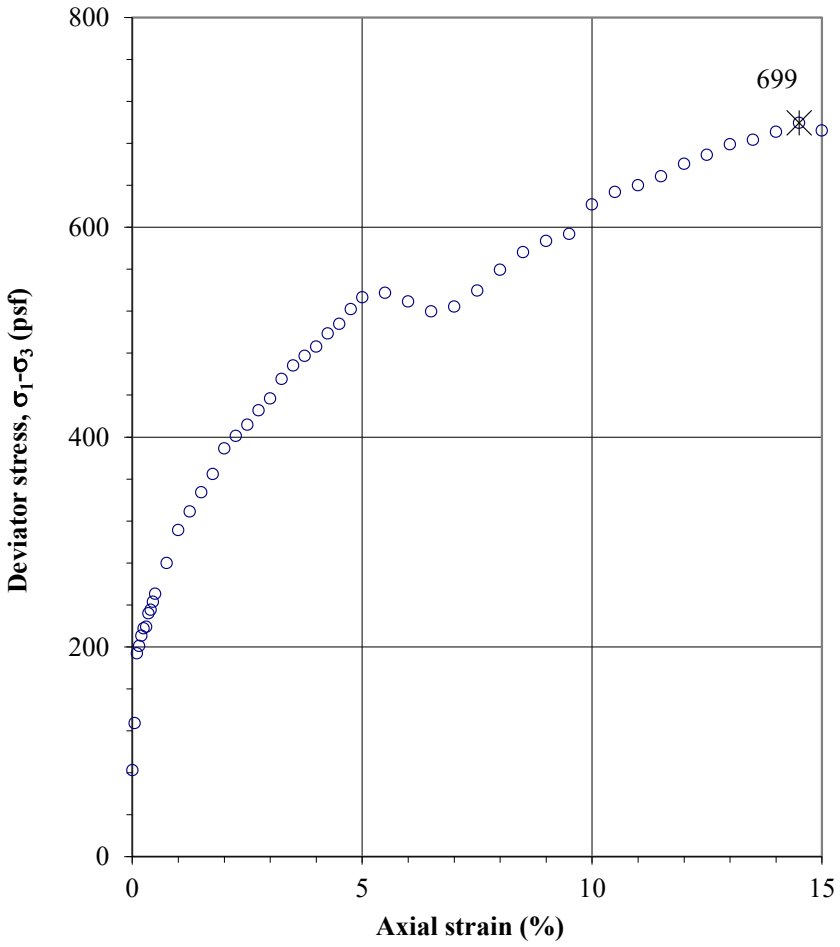
SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

Specific gravity, Gs	2.70	Assumed
Sample height, H (in.)	4.871	
Sample diameter, D (in.)	2.416	
Sample volume, V (ft^3)	0.0129	
Wt. rings + wet soil (g)	673.42	
Wt. rings/tare (g)	0.00	
Moist soil, Ws (g)	673.42	
Moist unit wt., γ_m (pcf)	114.9	
Dry unit wt., γ_d (pcf)	**84.6**	
Saturation (%)	97.1	
Void ratio, *e*	1.00	

Wet soil + tare (g)	817.97
Dry soil + tare (g)	642.34
Tare (g)	152.68
Water content, w (%)	**35.9**
Confining stress, σ_3 (psf)	3916
Shear rate (in/min)	0.0146
Strain at failure, ε_f (%)	14.50
Deviator stress at failure, $(\sigma_1-\sigma_3)_f$ (psf)	699
Shear stress at failure, $q_f = (\sigma_1-\sigma_3)_f/2$ (psf)	350

Axial Strain	σ_d $\sigma_1-\sigma_3$	Q 1/2 σ_d
0.00	82.1	41.1
0.05	127.1	63.5
0.10	193.5	96.8
0.15	200.6	100.3
0.20	210.4	105.2
0.25	217.4	108.7
0.30	218.9	109.5
0.35	231.6	115.8
0.40	235.1	117.6
0.45	242.8	121.4
0.50	250.3	125.2
0.75	279.7	139.8
1.00	311.2	155.6
1.25	328.7	164.4
1.50	347.1	173.6
1.75	364.5	182.2
2.00	388.9	194.4
2.25	400.9	200.5
2.50	411.5	205.8
2.75	425.2	212.6
3.00	436.6	218.3
3.25	455.3	227.6
3.50	467.8	233.9
3.75	477.0	238.5
4.00	485.9	242.9
4.25	498.4	249.2
4.50	507.6	253.8
4.75	521.8	260.9
5.00	533.0	266.5
5.50	537.2	268.6
6.00	529.0	264.5
6.50	519.4	259.7
7.00	524.2	262.1
7.50	539.5	269.7
8.00	559.2	279.6
8.50	575.9	287.9
9.00	586.6	293.3
9.50	593.5	296.8
10.00	621.6	310.8
10.50	633.2	316.6
11.00	639.7	319.8
11.50	648.4	324.2
12.00	660.1	330.0
12.50	668.7	334.4
13.00	678.9	339.4
13.50	683.3	341.6
14.00	690.6	345.3
14.50	699.2	349.6
15.00	692.1	346.1



Sample Location	B-10
Depth (ft)	35.0-36.5
Soil Type	CL

FIGURE B-23

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

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SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

APPENDIX C

Chemical Test Results

APPENDIX C

CHEMICAL TEST RESULTS

The results of the chemical tests are provided in this appendix.

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Certificate of Analysis

Ninyo and Moore
Edgar Salinas
871 Robinson Drive
North Salt Lake, UT 84054

PO#: **800272001**
Receipt: **5/24/23 16:47 @ 23.8** °C
Date Reported: 6/6/2023
Project Name: **800272001**

Sample ID: **B-3 @ 1.0-5.0**

Matrix: **Solid**
Lab ID: **23E2130-01**
Date Sampled: **5/9/23 9:15**
Sampled By: **Edgar Salinas**

	Result	Units	Minimum Reporting Limit	Method	Preparation Date/Time	Analysis Date/Time	Flag(s)
Inorganic							
Chloride, Soluble (IC)	34	mg/kg dry	12	EPA 300.0	5/25/23	5/25/23	
eH	356	mV	0.1	SM 2580 B	5/25/23	5/25/23	
pH	8.8	pH Units	0.1	EPA 9045D	5/25/23	5/25/23	
Resistivity	6.4	ohm m	1.0	SSSA 10-3.3	5/25/23	5/25/23	
Sulfate, Soluble (IC)	237	mg/kg dry	12	EPA 300.0	5/25/23	5/25/23	
Total Dissolved Solids, Soluble	67200	mg/kg dry	595	SM 2540 C	5/30/23	5/30/23	
Total Solids	84.0	%	0.1	CTF8000	5/26/23	5/26/23	
Metals							
Sodium, Total	3550	mg/kg dry	232	EPA 6010B/C/D	5/30/23	5/31/23	

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PO#: **800272001**
Receipt: **5/24/23 16:47 @ 23.8** °C
Date Reported: 6/6/2023
Project Name: **800272001**

Sample ID: **B-5 @ 6.0-10.0**

Matrix: **Solid**
Lab ID: **23E2130-02**
Date Sampled: **5/10/23 11:15**
Sampled By: **Edgar Salinas**

	Result	Units	Minimum Reporting Limit	Method	Preparation Date/Time	Analysis Date/Time	Flag(s)
Inorganic							
Chloride, Soluble (IC)	286	mg/kg dry	13	EPA 300.0	5/25/23	5/25/23	
eH	385	mV	0.1	SM 2580 B	5/25/23	5/25/23	
pH	8.4	pH Units	0.1	EPA 9045D	5/25/23	5/25/23	
Resistivity	4.0	ohm m	1.0	SSSA 10-3.3	5/25/23	5/25/23	
Sulfate, Soluble (IC)	193	mg/kg dry	13	EPA 300.0	5/25/23	5/25/23	
Total Dissolved Solids, Soluble	19400	mg/kg dry	645	SM 2540 C	5/30/23	5/30/23	
Total Solids	77.5	%	0.1	CTF8000	5/26/23	5/26/23	
Metals							
Sodium, Total	871	mg/kg dry	102	EPA 6010B/C/D	5/30/23	5/31/23	

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North Salt Lake, UT 84054

PO#: **800272001**
Receipt: **5/24/23 16:47 @ 23.8** °C
Date Reported: 6/6/2023
Project Name: **800272001**

Sample ID: **B-7 @ 6.0-7.5**

Matrix: **Solid**
Lab ID: **23E2130-03**
Date Sampled: **5/15/23 14:20**
Sampled By: **Edgar Salinas**

	Result	Units	Minimum Reporting Limit	Method	Preparation Date/Time	Analysis Date/Time	Flag(s)
Inorganic							
Chloride, Soluble (IC)	206	mg/kg dry	13	EPA 300.0	5/25/23	5/25/23	
eH	319	mV	0.1	SM 2580 B	5/25/23	5/25/23	
pH	8.9	pH Units	0.1	EPA 9045D	5/25/23	5/25/23	
Resistivity	4.8	ohm m	1.0	SSSA 10-3.3	5/25/23	5/25/23	
Sulfate, Soluble (IC)	68	mg/kg dry	13	EPA 300.0	5/25/23	5/25/23	
Total Dissolved Solids, Soluble	29700	mg/kg dry	648	SM 2540 C	5/30/23	5/30/23	
Total Solids	77.2	%	0.1	CTF8000	5/26/23	5/26/23	
Metals							
Sodium, Total	1370	mg/kg dry	153	EPA 6010B/C/D	5/30/23	5/31/23	

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Certificate of Analysis

Ninyo and Moore
Edgar Salinas
871 Robinson Drive
North Salt Lake, UT 84054

PO#: **800272001**
Receipt: **5/24/23 16:47 @ 23.8** °C
Date Reported: 6/6/2023
Project Name: **800272001**

Sample ID: **B-11 @ 20.0-21.5**

Matrix: **Solid**
Lab ID: **23E2130-04**
Date Sampled: **5/15/23 12:30**
Sampled By: **Edgar Salinas**

	Result	Units	Minimum Reporting Limit	Method	Preparation Date/Time	Analysis Date/Time	Flag(s)
Inorganic							
Chloride, Soluble (IC)	2940	mg/kg dry	131	EPA 300.0	5/25/23	5/26/23	
eH	295	mV	0.1	SM 2580 B	5/25/23	5/25/23	
pH	9.5	pH Units	0.1	EPA 9045D	5/25/23	5/25/23	
Resistivity	1.4	ohm m	1.0	SSSA 10-3.3	5/25/23	5/25/23	
Sulfate, Soluble (IC)	198	mg/kg dry	13	EPA 300.0	5/25/23	5/25/23	
Total Dissolved Solids, Soluble	23900	mg/kg dry	653	SM 2540 C	5/30/23	5/30/23	
Total Solids	76.6	%	0.1	CTF8000	5/26/23	5/26/23	
Metals							
Sodium, Total	3980	mg/kg dry	258	EPA 6010B/C/D	5/30/23	5/31/23	

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Project Name: **800272001**

Report Footnotes

Abbreviations

ND = Not detected at the corresponding Minimum Reporting Limit (MRL).
1 mg/L = one milligram per liter or 1 mg/kg = one milligram per kilogram = 1 part per million.
1 ug/L = one microgram per liter or 1 ug/kg = one microgram per kilogram = 1 part per billion.
1 ng/L = one nanogram per liter or 1 ng/kg = one nanogram per kilogram = 1 part per trillion.
On calculated parameters, there may be a slight difference between summing the rounded values shown on the report vs the unrounded values used in the calculation.

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On calculated parameters, there may be a slight difference between summing the rounded values shown on the report vs the unrounded values used in the calculation.

APPENDIX D

Refraction Microtremor Survey Results

APPENDIX D

REFRACTION MICROTREMOR SURVEY RESULTS

Ninyo & Moore performed a ReMi survey to obtain the shear wave velocity profile to a nominal depth of approximately 100 feet at the subject site to evaluate Seismic Site Class in general accordance with the 2018 International Building Code (ICC, 2018). The approximate length and orientation of the survey array is indicated on Figure 2. Data was collected to a depth of approximately 100 feet using a using 24-Channel Geometrics Geode exploration seismograph coupled with 24 vertical component 4.5 Hertz geophones spaced approximately 20 feet apart. Ambient noise (microtremors) was recorded for a total period length of 30 seconds. The results of the ReMi survey are provided on Figure D-1.

The calculated average shear wave velocities to a depth of approximately 100 feet at the location of the geophone array measured at 613 feet per second. Based on this information, a Seismic Site Class D is characteristic for design purposes for the project site.

Refraction MicroTremor (ReMi) Survey

Shear Wave Velocity v. Depth

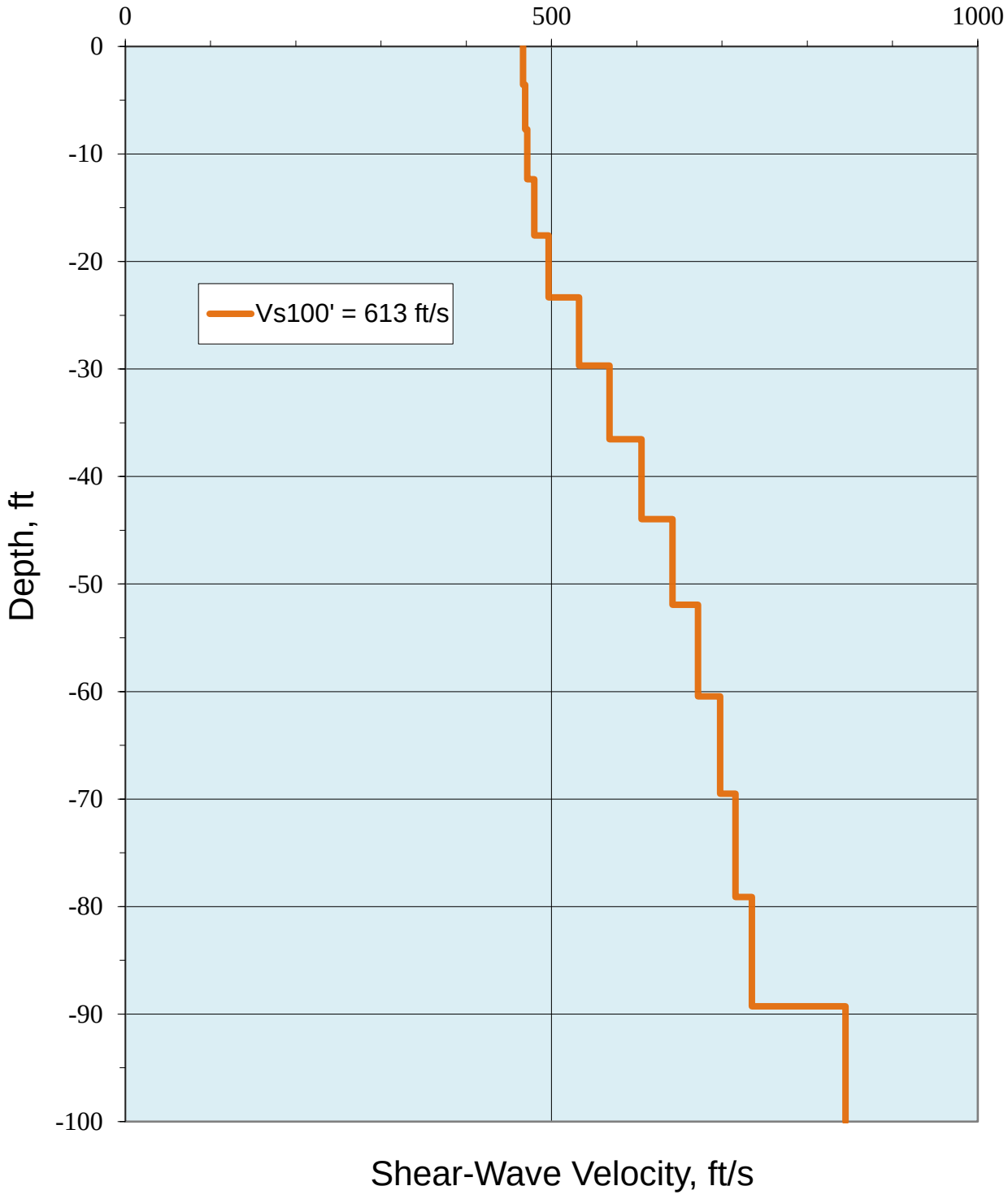
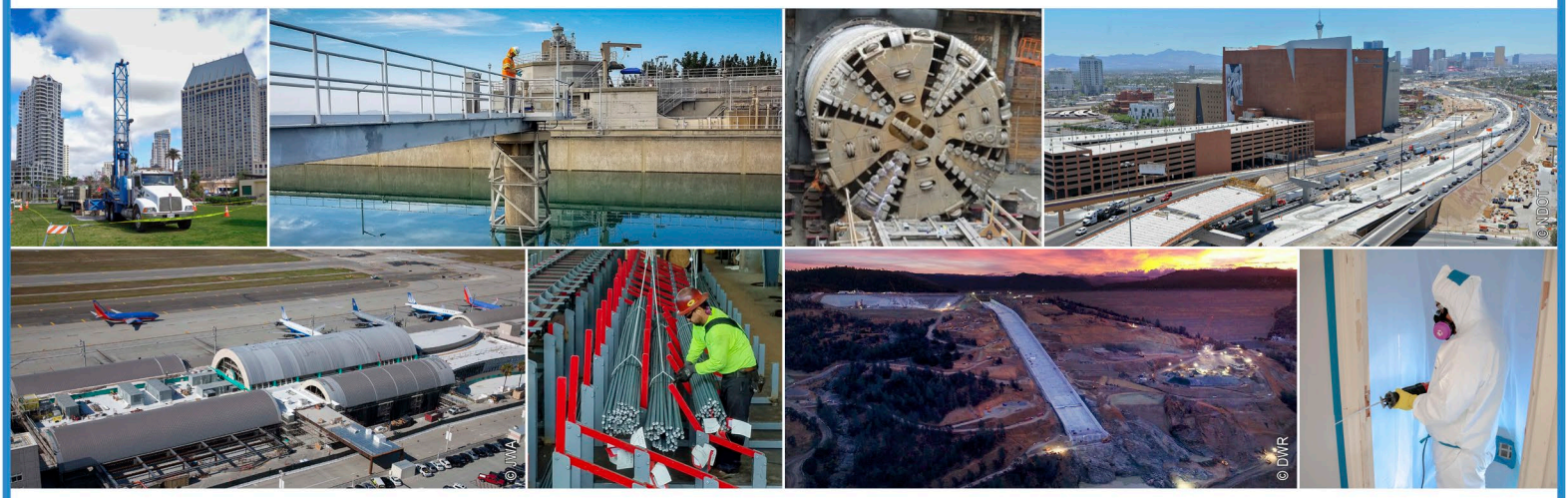


FIGURE D-1

REMI SURVEY RESULTS

SOUTH DAVIS SEWER DISTRICT NORTH PLANT ADDITIONS
1800 WEST 1200 NORTH, WEST BOUNTIFUL, UTAH

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants



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