



MARIN COUNTY, CALIFORNIA

VOLUME 3

TECHNICAL SPECIFICATIONS FOR

TWAS ENCLOSURE/SLUDGE BASIN AND RECEPTION PAD

JOB NO. 12600-07/16650-02

MAY 2023

FOR BIDDING PURPOSES ONLY

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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. Phased construction.
4. Work under separate contracts.
5. Access to site.
6. Coordination with occupants.
7. Work restrictions.
8. Specification and drawing conventions.
9. Miscellaneous provisions.

B. Related Requirements:

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

1.2 PROJECT INFORMATION

A. Project Identification: **TWAS Enclosure & Sludge Storage**

1. Project Location: 300 Smith Ranch Road, San Rafael, California 94903

B. Owner: Las Gallinas Valley Sanitary District (LGVSD)

C. Design Engineer: AQUA Engineering, (801) 299-1327

D. Construction Managers: TBD

E. Owner's Programmer: ArcSine Engineering 530-222-7204

1. Consultants have been engaged for this Project to provide engineering and construction services and to serve as Project's coordinator.

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. 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 all site improvements as indicated in the Contract Documents.
4. Installation of awning/cover for WAS thickening (TWAS) equipment and construction of adjacent chemical storage/enclosure.
5. Construction of sludge storage basin and reception pad.
6. All associated site grading, yard piping, electrical, valving, paving, retaining walls, concrete walkways, and other appurtenances as indicated in the design drawings and specifications.
7. Coordination of all construction activities with plant operators to ensure the reliable and efficient operation of the plant during construction and transition to new processes. The WWTP is an active plant that must remain operational at all times.
8. Project Construction Survey – The Contractor shall be responsible to survey the location of all buried piping and fittings. The survey information shall be presented on the Record Drawings and each surveyed point shall have the Station, Offset, Elevation information and a brief description. The survey shall be performed and data certified by a licensed surveyor in the State of California.
9. Coordination with the District’s Programmer, including startup and testing.

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 Volume I, “Contract Documents.” Electronic copies of the existing plant drawings will be available to the successful Contractor through the same means. Please note that hard copies of “record drawings” or “as-constructed drawings” from previous construction projects are not available. The contractor may produce hard copies as they may require internally from the electronic files provided.

1.5 PHASED CONSTRUCTION

- A. The Work shall be conducted in accordance to an approved Contractor Schedule.
 - 1. Work on the project shall commence simultaneously with the Notice to Proceed and be substantially complete and ready for occupancy three hundred ninety (390) calendar days after the Notice to Proceed. All time-frames referencing “days” in the following description assume calendar days unless specifically stated otherwise. It is expected that the project will consist of several phases due to the need to keep the facility operational during the construction. Phasing of the project will require continuous coordination between the Plant staff and the Contractor as the plant needs to be operational during the construction.
- B. Phases: The sludge storage basin and TWAS enclosure are not directly related and can be installed simultaneously or in sequence. The Contractor is responsible for all coordination and scheduling with the plant manager and personnel. The Contractor shall verify that all processes are available before the start-up of the systems. The Engineer is not responsible for scheduling the Contractor’s work.
- C. The Contractor’s Schedule shall include work phases and completion dates. It shall also be coordinated with the phasing and sequencing plan. It is anticipated and expected that all work will begin with the Notice to Proceed and only the completion dates of individual aspects of the project will be different. Items in later phases may be completed earlier based on an approved Contractor Schedule.
- D. The Contractor shall prepare and submit phasing/sequencing plans for all major areas of work prior to the commencement of the work in that area. These plans will detail and sequence the general work flow, tie-ins, electrical work, and also address maintaining plant operations and permit compliance. Plans shall be submitted within 60 days to the Owner, Engineer, and Construction Manager for review and approval just like other submittals. Phasing/sequencing meetings may be required to work through more complicated areas and to insure coordination with plant operations. The contractor may use the individual process sequencing listed above as a basis to propose construction phasing/sequencing. When developing the phasing/sequencing 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.
- E. There will be several local tie-ins and shut downs in order to bring on-line new equipment and infrastructure. The contractor shall coordinate ahead of time local tie-ins and shut-downs 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.
- F. While localized shut downs 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.

- G. 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.

1.6 OWNER FURNISHED EQUIPMENT

There is no Owner Furnished Equipment associated with this project.

1.7 OWNER SELECTED EQUIPMENT

- A. The Contractor shall be responsible to purchase, receive, offload, inspect, store, and install Owner Selected Equipment.
- B. See specification section 151100 for additional requirements and details.

1.8 ACCESS TO SITE

- A. General: Contractor shall have access to the 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. Contractor shall coordinate and confirm with Owner the 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. This includes maintaining access to the county facility located just south of the MMWD treatment facility.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
- C. The Contractor shall place a project sign at least four feet tall by eight feet wide made of ¾ inch thick exterior grade plywood or other approved material in a prominent location on the Project site and shall maintain the sign in good condition for the duration of the construction period. Insert other paragraphs, as appropriate, describing additional limitations on use of site by construction personnel. See Evaluations for model text.

1.9 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy site and existing building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day 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 approval of authorities having jurisdiction.
 2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.
- B. 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.
- C. 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. Engineer 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 at the existing site to normal business working hours, which are 7:00 AM to 6:00 PM Monday through Friday and 9:00 AM to 6:00 PM on Saturday with Sunday and Holidays being prohibited. Work outside these hours must be approved by the District.**
- 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 72 hours 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 72 hours in advance of proposed disruptive operations.
 2. Additional limits on allowable vibrations are applicable for shoring/pile driving required for excavation near existing structures and improvements. Refer to Sections 312000 and 315000 for additional details.
- E. Smoking requirements are to comply with California 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. Requests for Change (RFCs)
 - 4. Project Web site.
 - 5. Project meetings.

1.2 DEFINITIONS

- A. RFI: Request from Owner, Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.
- B. RFC: Request from Contractor proposing a change to the contract requirements.

1.3 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.

1.4 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.

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
 - 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
 - 1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid.
 - 2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings.
 - 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 - 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.

5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Review: Engineer will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility.

1.6 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. A sample RFI form is included at the end of this Specification.
 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.
 3. Owner or Engineer will not review the Contractor's RFIs that are in fact Requests for Changes (RFCs), as determined by the Owner. In such cases, Contractor will be required to resubmit on the appropriate RFC form.
- 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. PST 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 a Change Proposal.
 - 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.

1.7 REQUEST FOR CHANGE (RFCs)

- A. Contractor shall submit a Request for Change when Contractor proposes a change in the Contract requirements. All change requests shall be submitted on the RFC form attached to this Specification. As shown therein, Contractor is required to fully describe the benefit(s) to the Owner, benefit(s) to the Contractor, the cost and/or schedule impact(s) associated with the requested change, along with whether or not Contractor proposes or requires a Contract Change Order for implementing the change. Except for as described in Section 1.6 herein, any Contractor RFC that is submitted on the RFI form will be returned without review.
- B. As noted on the RFC form, it is understood that certain RFCs can be responded to promptly, with minimal expenditures required by Owner. It is also understood that other RFCs require significant expenditures by Owner in order to properly evaluate and respond to Contractor's RFC. For those RFCs that fall in the latter category, Owner will provide an estimate (time and money) to

Contractor as an initial response to RFC. Contractor may then elect to have Owner proceed with evaluating Contractor's RFC (with estimated value deducted from Contractor's Contract with the Owner), or elect to withdraw Contractor's RFC.

1.8 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 disruptions and shutdowns.
 - r. Construction waste management and recycling.
 - s. Parking availability.
 - t. Office, work, and storage areas.
 - u. Equipment deliveries and priorities.
 - v. First aid.
 - w. Security.

- x. 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. Contractor shall prepare three-week look ahead schedules for review at each progress meeting. The three-week look ahead schedules are not an acceptable substitute for CPM schedule updates that must be submitted with Contractor's monthly partial payment requests.
 - c. 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.
4. It is noted that inspection will not be provided during scheduled progress meetings. Contractor is not permitted to perform work that requires inspection (as determined by Owner) during the progress meetings. Contractor shall adjust his schedule to accommodate said bi-weekly progress meetings and no additional compensation will be provided for same. Contractor's bid shall consider Owner's requirements for weekly progress meetings. Owner, at its sole discretion, may decrease the frequency of progress meetings if deemed appropriate.

1.9 WORKSHOPS

- A. The Contractor shall schedule, prepare agendas, conduct, and prepare minutes for coordination workshops. The workshops shall be attended by:
 1. Contractor's Project Manager.
 2. A lead technical person within the organization providing startup/commissioning coordination.
 3. Other members of the Contractor's organization.
 4. Owner's Programmer.
 5. Owner's representatives.
 6. Other parties as required.
- B. These workshops shall be in addition to any other specified or required meetings for general project scheduling and coordination. These workshops shall be dedicated to the technical and coordination aspects of Plant controls. The workshops, and related recordkeeping shall capture workshop technical and coordination items, identify who within the Contractor's organization is accomplishing the Contractor's activities, making technical decisions, documenting those decisions, identifying and overcoming any obstacles, and related activities.
- C. Workshops shall be by teleconference or in-person at the Plant, as noted. However, the District will consider, but is under no obligation to, allow selected parties to attend remotely. In this case, the Contractor shall provide suitable means to cover the subject matter (such as Web-X, etc.)
- D. Within 8 weeks of the Notice-To Proceed the Contractor shall submit a draft workshop schedule package, which includes the following:
 1. Names, organizations, and detailed contact information for each proposed participant.
 2. A list of workshops, with a participant matrix. Also, indicate suggested Owner representatives.
 3. Draft high-level Agendas for each workshop. (Detailed Agendas submissions are also required prior to each workshop.)
 4. Rough workshop schedule, with detailed consideration of related activities. For example, workshops which have a bearing on shop drawing development should be scheduled in advance.
- E. Except where noted otherwise, allow 5 hours for each workshop. Tailor the agendas as needed, including the topics noted in this Specification. Prior to each workshop submit a detailed

Agenda, with accompanying documents where warranted. Receive and incorporate review comments. Following the workshop submit minutes.

- F. Throughout of the workshops series the Contractor shall develop and maintain the following records:
 - 1. Action Item List
 - 2. Decision Log

- G. Throughout the workshop series the Contractor shall maintain red marks on the following categories of Contract Documents, also annotated with the origins of the changes. Where applicable, copies of the red-marked documents should be included in the workshop preparations and results.
 - 1. Process and Instrumentations diagrams
 - 2. Input/output lists
 - 3. Block diagrams

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

SAMPLE
CONTRACTOR'S REQUEST FOR INFORMATION (RFI) # _____

To (Engineer):	
From (Contractor):	
Subject:	
Reference: Construction Drawing:	Specification (Section and Page):
REQUEST	
Information is requested as follows:	
Information Requested By (Name):	Date:
Response Requested By (Date):	
Received by CM (Date):	
RESPONSE	
Response to Information Request:	
Response By (Name):	Date:

Final Distribution:

Page ___ of ___

SAMPLE
CONTRACTOR'S REQUEST FOR CHANGE (RFC) # _____

To (Engineer):	
From (Contractor):	
Subject:	
Reference: Construction Drawing:	Specification (Section and Page):
REQUEST	
The following change is requested:	
Change Requested By (Name):	Date:
Response Requested By (Date):	
Received by CM (Date):	
Benefit to Owner:	
Benefit to Contractor:	
Cost and/or Schedule Impact:	
Change Order Required or Proposed? ___ YES ___ NO	
RESPONSE	

Response to Change Request: ⁽¹⁾

RESPONSE (Continued)

Response By (Name):

Date:

(1) It is understood that certain RFCs can be responded to promptly, with minimal expenditures required by Owner. It is also understood that other RFCs require significant expenditures by Owner in order to properly evaluate and respond to Contractor's RFC. For those RFCs that fall in the latter category, Owner will provide an estimate (time and money) to Contractor as an initial response to RFC. Contractor may then elect to have Owner proceed with evaluating Contractor's RFC (with estimated value deducted from Contractor's Contract with Owner), or elect to withdraw Contractor's RFC.

Final Distribution:

END OF SECTION 013100

SECTION 013110 – SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

- A. The Contractor shall develop the Schedule of Values (lump sum price breakdown) to be incorporated into the cost loading function of the Construction Schedule as specified in Section 013100. Monthly progress payment amounts shall be determined from the monthly progress updates of the Construction Schedule activities.
- B. The Schedule of Values shall be developed independent of but simultaneous with the development of the Construction Schedule activities and logic as follows:

1.2 RELATED SECTIONS

- A. The Work of the following Sections apply to Work of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of the Work.
 - 1. Measurement and Payment (General Conditions Section 9)
 - 2. Section 013100 Project Management and Coordination
 - 3. Section 013200 Construction Progress Documentation

1.3 SUBMITTALS

- A. Preliminary Schedule of Values
- B. Detailed Schedule of Values

PART 2 - PRODUCTS

2.1 PRELIMINARY SCHEDULE OF VALUES

- A. The CONTRACTOR shall submit a preliminary Schedule of Values for the major components of the Work at the Preconstruction Conference in accordance with Section 013100, 1.8, B. The listing shall include a detailed breakdown of cost for each lump sum bid item.

The CONTRACTOR and CONSTRUCTION MANAGER shall meet and jointly review the preliminary Schedule of Values and make any adjustments in value allocations if, in the opinion of the CONSTRUCTION MANAGER, these are necessary to establish fair and reasonable allocation of values for the major Work components. Front end loading will not be permitted. The CONSTRUCTION MANAGER may require reallocation of major Work components from items in the above listing if in the opinion of the CONSTRUCTION MANAGER such reallocation is necessary.

2.2 DETAILED SCHEDULE OF VALUES

- A. The CONTRACTOR shall prepare and submit a detailed Schedule of Values to the CONSTRUCTION MANAGER within 30 days from the date of Notice to Proceed. The detailed Schedule of Values shall be based on the accepted preliminary Schedule of Values for major Work components. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts through cost loading of the Construction Schedule activities, sufficient detailed breakdown shall be provided to meet this requirement. The CONSTRUCTION MANAGER shall be the sole judge of acceptable numbers, details and description of values established. If, in the opinion of the CONSTRUCTION MANAGER, a greater number of Schedule of Values items than proposed by the CONTRACTOR is necessary, the CONTRACTOR shall add the additional items so identified by the CONSTRUCTION MANAGER.
1. The minimum detail of breakdown of the major Work components is indicated below. Greater detail shall be provided as directed by the CONSTRUCTION MANAGER.
 - a. Mobilization - no breakdown required.
 - b. The electrical Work shall be broken down by structure and yard facilities. Structures electrical Work shall be broken down into conduit and raceway installation, cable and wire installation, electrical equipment installation, terminations and lighting. Yard facilities shall be broken down by duct bank designation and substations.
 - c. Instrumentation and Control Work shall be broken down by structure.
 - d. Protective Coating Work shall be broken down by structure and yard area. Where specific coating Work at structures or yard areas may be critical to performing the Work to meet milestone and Contract dates, such Work shall be included as individual cost and Construction Schedule activity items.
 - e. Site preparation and demolition Work shall be broken down by site and structure. Each item of work shall be an individual cost item unless otherwise allowed by the CONSTRUCTION MANAGER.
 - f. Mechanical Work shall be broken down within each structure to identify individual piping systems, equipment installation by equipment name and number, and equipment testing and checkout.
 - g. Concrete structures shall be broken down into excavation, subgrade preparation, and appurtenant prefoundation Work, concrete foundation construction, slabs on grade, walls/columns, suspended slabs, stairs, etc. (sufficient breakdown shall be provided to accommodate necessary Schedule detail), hydrostatic structure testing where required and backfill.
 - h. Site improvement Work shall be broken down into individual drainage piping, drainage structures, site concrete, paving, excavation cut and fill, removal of existing pipe, clearing and grubbing and any other items determined to be necessary for the establishment of cost and Construction Schedule Activity items.
 - i. Equipment testing and plant startup broken down for completion milestones for each.
 - j. All other Work not specifically included in the above items shall be broken down as necessary for establishment of cost and Construction Schedule activity items.
 - k. Manways, air vacuum assemblies, yard valves, and blowoff assemblies, shall be broken down into excavation, backfill, pipelines, valves, concrete, piping, pipe fittings and specials, and any other item necessary for establishment of cost and construction schedule activity items.
 - l. Plant shutdowns and tie-ins to existing facilities; including structures, pipelines, MCCs, etc.

The CONTRACTOR and CONSTRUCTION MANAGER shall meet and jointly review the detailed Schedule of Values within 35 days from the date of Notice to Proceed. The value allocations and extent of detail shall be reviewed to determine any necessary adjustments to the values and to determine if sufficient detail has been proposed to provide cost loading of the Construction Schedule activities.

2. Following acceptance of the detailed Schedule of Values, the CONTRACTOR shall incorporate the values into the cost loading portion of the Construction Schedule. The Construction Schedule activities and logic shall have been developed concurrent with development of the detailed Schedule of Values, however, it shall be necessary to adjust the detailed Schedule of Values to correlate to individual Schedule activities. It is anticipated that instances will occur, due to the independent but simultaneous development of the Schedule of Values and the Construction Schedule activities, where interfacing these two documents will require changes to each document. Schedule activities may need to be added to accommodate the detail of the Schedule of Values. Schedule of Value items may need to be added to accommodate the detail of the Construction Schedule activities. Where such instances arise, the CONTRACTOR shall propose changes to the Schedule of Values and to the Construction Schedule activities to satisfy the Construction Schedule cost loading requirements.

2.3 CROSS REFERENCE LISTING

- A. To assist in the correlation of the Schedule of Values and the Construction Schedule, the CONTRACTOR shall provide a Cross Reference Listing which shall be furnished in two parts. The first part shall list each Scheduled Activity with the breakdown of the respective valued items making up the total cost of the activity. The second part shall list the valued item with the respective Scheduled Activity or Activities that make up the total cost indicated. In the case where a number of schedule activities make up the total cost for a valued item (shown in the Schedule of Values) the total cost for each scheduled activity should be indicated.
- B. These listings shall be updated and submitted in conjunction with the Construction Schedule monthly submittals as stated in Section 013200 - Construction Progress Documentation.
- C. Approved change orders reflected in the Construction Schedule shall be incorporated into the Schedule of Values as a single unit identified by the change order number.

2.4 CHANGES TO SCHEDULE OF VALUES

- A. Changes to the Construction Schedule which add activities not included in the original schedule but included in the original Work (schedule omissions) shall have values assigned as approved by the CONSTRUCTION MANAGER. Other activity values shall be reduced to provide equal value adjustment increases for added activities as approved by the CONSTRUCTION MANAGER.
- B. In the event that the CONTRACTOR and CONSTRUCTION MANAGER agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made.

PART 3 - PRODUCTS

3.1 SCHEDULE OF VALUES SUBMITTAL

- A. Preliminary Schedule of Values shall be completed and submitted within 15 days from the date of Notice to Proceed, or at the preconstruction conference, whichever occurs first.
- B. Detailed Schedule of Values shall be completed and submitted within 30 days from the date of Notice to Proceed.
- C. Following a meeting and joint review of the CONTRACTOR's detailed Schedule of Values by the CONTRACTOR and the CONSTRUCTION MANAGER, CONTRACTOR will submit a revised detailed Schedule of Values within 30 days of the date of Notice to Proceed.

END OF SECTION 013110

SECTION 013130 - SAFETY

PART 1 - GENERAL

1.1 SUMMARY

- A. Contractor's safety program shall conform to the requirements specified in the General Conditions and Supplementary Conditions.
- B. This specification provides general guidance for site safety and a site safety program. This specification is supplemental to but does not replace or supersede the **District Safe Work Requirements and Confined Space Entry Program**. These documents may be requested from the District for reference.

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 California Occupational Safety and Health Administration (CAL 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 as defined in the General Conditions of the Contract.
 - 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 the CAL OSHA Enforcement Branch Program.
 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 have 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 containing 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 CALOSHA for working in classified areas,
- C. The following table is provided as a reference to the guidelines provided in NFPA 820 regarding classified areas that are in or near the construction area associated with this project:

Location	Classification/Description	Fire Protection Requirement*
Headworks Screen Channels	Open to Atmosphere – Class 1/Div 2 for a 10-foot envelope around open channel (vertical and horizontal).	FE, H
Grit Chambers	Open to Atmosphere – Class 1/Div 2 for a 10-foot envelope around open basin (vertical and horizontal).	FE, H
Primary Clarifiers	Open to Atmosphere - Class 1/Div 2 for an envelope extending 18-inches above basin top of wall and horizontally for 3-feet from the edge of the basin wall.	H
Scum Pits	Open to Atmosphere – Class 1/Div 2 for a 10-foot envelope around open channel/pit (vertical and horizontal).	FE, H
Sludge Storage	Enclosed (non-ventilated) – Class 1/Div 1 for the entire space.	FE, H, OCG
Sludge Thickener	Open to Atmosphere - Class 1/Div 2 for an envelope extending 18-inches above basin top of wall and horizontally for 3-feet from the edge of the basin wall.	H
Flares	Class 1/Div 1 for a 10-foot envelope around fixtures and housing. Class 1/Div 2 for additional 15-feet vertically above the Class 1/Div 1 envelope.	-
Biogas Storage	Open to Atmosphere – Class 1/Div 1 for a 10-foot envelope around storage vessel.	FE

* Fire Protection Requirements Code (per NFPA 820) – additional precautions required to have on site in or immediately adjacent to area.
FE: Fire Extinguisher
H: Hydrant access and protection per 7.2.4
CGD: Combustible gas detection (treat as confined space including CGD monitoring when entering the space).

END OF SECTION 013130

SECTION 013200 – CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

- A. The CONTRACTOR'S planning, scheduling and execution of the Work shall be presented to the OWNER by submission of the Construction Schedule information and data specified in this Section.

1.2 RELATED SECTIONS

- A. The Work of the following Section applies to Work of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of the Work.
 1. Measurement and Payment (General Conditions Section 9)
 2. Section 013300 Submittals
 3. Section 013110 Schedule of Values

1.3 SUBMITTALS

- A. Interim Construction Schedule.
- B. Detailed Construction Schedule.
- C. Monthly Construction Schedule Updates.
- D. Construction Schedule Revisions.
- E. Sub-Network Analysis.

1.4 CONSTRUCTION SCHEDULE - GENERAL

- A. Provide, maintain, and use a computer-based Construction Schedule utilizing a cost-loaded, critical path method (CPI) network analysis system showing in detail the CONTRACTOR'S plan to execute and coordinate Work. The Construction Schedule shall include in cost-loaded, critical path method (CPM) the following:
 1. Milestones and the Completion Date specified in the Contract Agreement.
 2. The order in which Work shall be performed.
 3. Planned dates of start-up and testing for equipment, subsystems, and systems.
 4. Activities and matters involving mutual support between Contractor, Subcontractors, Suppliers, and OWNER.
- B. The CONTRACTOR is responsible for coordinating its own schedules (including subcontractors) as well as construction activities of others as directed by the CONSTRUCTION MANAGER. The CONTRACTOR should refer to the Construction Schedule to ensure that project site coordination and work by others at the site properly depicts the CONTRACTOR'S planning. In preparing all contract schedules, it is the responsibility of the CONTRACTOR to work with each subcontractor and supplier to

obtain information pertinent to the planning and updating of their respective activities and schedules.

1.5 SCHEDULE SOFTWARE

- A. The CPM Schedule and all reports shall be prepared with Primavera Project Planner (P6). The CONTRACTOR shall provide all schedules and schedule updates using hard copy and electronic files on USB thumb drives.

1.6 CONSTRUCTION SCHEDULE ACTIVITIES

- A. Each activity shall include the following attributes:
 - 1. Sub CIP number.
 - 2. Responsibility Code such as Owner, Construction Manager, Contractor, Sub-Contractor, Supplier.
 - 3. Resources.
 - 4. Duration.
 - 5. Remaining Duration.
 - 6. Activity Identification.
 - 7. Title.
 - 8. Cost in accordance with Section 013110 Schedule of Values.
- B. The CPM Schedule activities shall be cost-loaded based upon the Schedule of Values as approved by the CONSTRUCTION MANAGER in accordance with the requirements of Section 013110.
- C. The contract schedules shall show the breakdown of Work into activities and relationships to the extent required to effectively manage the Work. The contract schedules shall show the division of the Work into activities and specify the progression from the Notice to Proceed to the end of the Work. The contract schedule shall include appropriate time allowances and constraints for submittals, items of interface with work performed by others, and specified construction, start-up and performance tests. Activities shall not reflect a combining of Work located in separate Work areas, Work corresponding to different divisions of the Contract Documents, work performed by different subcontractors (first and second tiers), or rough-in and finish work of the same trade. The duration estimate for each activity shall be in working days and shall represent the single best estimate considering the scope of the activity work and the resources planned for the activity. The maximum duration of any activity shall be fifteen (15) working days, unless approved by the CONSTRUCTION MANAGER.
- D. The contract schedules shall be in a precedence diagram format, shall be plotted with a time-scaled calendar, and shall expressly identify the contract time, milestones, the critical path(s), and all activities. Activities shall be shown on their early dates, with total float noted. Connections between activities, whether on the same sheet or on different sheets, shall identify both predecessor and successor work. Activity data shall include description of the Work, activity costs, activity duration, and special codes. The use of start or finish restraint dates other than the ones specified in the Contract Documents must be approved by the CONSTRUCTION MANAGER.
- E. The CONTRACTOR'S Construction Schedule shall include all procurement related activities which lead to the delivery of permanent materials to the site in a timely manner.

Procurement activities should include, but not be limited to, preparation of Shop Drawings, review and approval of Shop Drawings, materials fabrication, materials delivery, etc., as appropriate. Upon written approval of the CONSTRUCTION MANAGER, these activities may be displayed or reported as a separate Off-Site Activities Schedule, properly correlated to the CONTRACTOR'S Construction Schedule.

The CONTRACTOR shall schedule the requisite duties and responsibilities of the OWNER, the CONSTRUCTION MANAGER and others (performing work for the OWNER) indicated in or required by the Contract Documents within the contract time. The contract schedules shall incorporate appropriate activities and sequences based on the information given in the Contract Documents, and if not given, as indicated by the CONSTRUCTION MANAGER, in writing.

1.7 DEALING WITH SUBSTITUTES

- A. All versions of the CONTRACTOR'S schedule shall be based solely on the Work awarded, and shall exclude any material or equipment substitution proposals, even if the CONTRACTOR pursues a substitution in accordance with provisions of the Contract.
- B. The OWNER'S final determination on any proposed substitutions may not be made until after the CONTRACTOR'S Detailed Construction Schedule is prepared and accepted as provided in this Section.

1.8 USE OF FLOAT

- A. Total Float is the number of days by which a part of the Work in the Construction Schedule may be delayed from its early dates without necessarily extending the contract time. Contract Float is the number of days between the CONTRACTOR'S anticipated date for early completion of the Work, or specified part, and the corresponding contract time. Total Float and Contract Float belong to the project and are not the exclusive benefit of any party. They shall be available to the OWNER or the CONTRACTOR, to accommodate changes in the Work, or to mitigate the effect of events which may delay performance or completion.

1.9 EARLY COMPLETION

- A. An early completion schedule is one which anticipates completion of all or specified part of the Work ahead of the corresponding contract time. Since Contract Float belongs to the Project, the CONTRACTOR shall not be entitled to any extension in contract time, or recovery for any delay incurred because of extensions in an early completion date, until all Contract Float is used or consumed and performance or completion of the Work extends beyond the corresponding contract time. The CONTRACTOR shall adjust or remove any Float suppression techniques, e.g., preferential sequencing (crew movements, equipment use, form reuse, etc.), extended durations, imposed dates, scheduling of Work not required for a contract time as required Work, and others, as a prerequisite to a request for an increase in contract price or contract time. Use of restraint dates should be minimized and require approval by the CONSTRUCTION MANAGER.

PART 2 - PRODUCTS

2.1 CONSTRUCTION SCHEDULE – INTERIM

- A. The Interim Construction Schedule submittal shall depict Work to be performed during the first 60 working days of the project. Include the following:
 - 1. Bar chart consisting of horizontal lines, or bars plotted along a daily time scale.
 - 2. The horizontal bars shall indicate start and finish dates for each activity depicted.
 - 3. The bar chart shall show the accomplishment of the CONTRACTOR'S early activities (mobilization, permits, submittals necessary for early material and equipment procurement, submittals necessary for long lead equipment procurement, CPM submittals, initial site work and other activities required or anticipated in the first 60 days).
- B. The Interim Construction Schedule will be superseded upon acceptance of the Detailed Construction Schedule described below.
- C. Include activities comprising the Interim Schedule in the Detailed Construction Schedule.

2.2 CONSTRUCTION SCHEDULE – DETAILED

- A. The Detailed Construction Schedule submittal shall consist of the time scaled CPM logic diagrams, activity reports, cost and resource reports, narrative, and a USB thumb drive with CPM software files duplicating the CONTRACTOR'S files in a P6 format CPM reports in the following sorts, shall be provided by the CONTRACTOR:
 - 1. Critical Path. Report (sorted by Early Start).
 - 2. Activity report sorted by Total Float.
 - 3. Responsibility Schedule Report.
 - 4. Successor-Predecessor Report.
 - 5. 60-day Look Ahead Report.
 - 6. Three (3) Week Look Ahead Report.
 - 7. Cost Summary.
- B. No Work shall be scheduled on OWNER Holidays without prior written approval from the CONSTRUCTION MANAGER. OWNER holidays are:
 - 1. January 1st, New Year's Day";
 - 2. Third Monday in February, "President's Birthday";
 - 3. Last Monday in May, "Memorial Day";
 - 4. July 4th, "Independence Day";
 - 5. First Monday in September, "Labor Day";
 - 6. Fourth Thursday in November, "Thanksgiving Day";
 - 7. Day after Thanksgiving in November;
 - 8. December 24th, "Christmas Eve";
 - 9. December 25th, "Christmas Day".

2.3 CONTRACTORS CONSTRUCTION SCHEDULE

- A. When the Detailed Construction Schedule Submittal is reviewed and accepted it becomes the CONTRACTOR'S baseline schedule and is referred to as the CONTRACTOR'S Construction Schedule. From then on, all activities and their relationships may not be changed, added, or deleted without the consent of both the CONSTRUCTION

MANAGER and the CONTRACTOR. All changes must be reviewed and approved by the CONSTRUCTION MANAGER. Contract time (including all contracted milestones) cannot be changed without a formal Change. Order approved by the OWNER.

2.4 SCHEDULE NARRATIVES

- A. The Schedule Narrative accompanying the Detailed Construction Schedule submittal shall stand alone in describing the approach to the Work and the rationale used to develop the schedule relationships and logic. The written narrative shall describe critical activities, number of shifts per day, number of hours per shift, and the composition and number of crews and equipment to be utilized on each critical activity.
- B. The Schedule Narratives accompanying each subsequent schedule update and/or revision shall, at a minimum, compare the current early dates versus the corresponding baseline dates for milestones and the contract time. It shall also provide sufficient detail to allow verification of the progress of the Work, identify the assumptions made in incorporating work related to Change Orders, describe actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact, and itemize any proposed changes in network activities and sequences, and their basis.

2.5 SCHEDULE REVISIONS

- A. Construction Schedule revisions shall accurately represent all changes and adjustments in the sequencing and timing of Work remaining. The schedule revisions shall incorporate all changes which have been agreed upon in Change Orders approved since the last revision. These revisions shall reflect the requirements of the applicable Change Orders. Schedule revision costs shall be included in all Change Orders and shall be limited to \$200 or 5% of the Change Order total, whichever is less.
- B. The Construction Schedule revision shall consist of the time scaled CPM logic diagrams, activity reports, cost and resources reports, narrative, and a copy of CPM software files duplicating the CONTRACTOR'S files in a P6 format. The CPM reports shall be sorted in the same manner as the Construction Schedule.
- C. Each Construction Schedule revision shall be assigned a revision number, starting with "Rev. 0" on the CONTRACTOR'S Construction Schedule for the Work as awarded. Resubmittals shall use the same revision number followed by the letters "A", "B", etc., as applicable.
- D. When a delay or disruption to the Work is identified.

PART 3 - EXECUTION

3.1 INTERIM CONSTRUCTION SCHEDULE

- A. Submit Interim Construction Schedule within ten (10) working days after the Pre-Construction Conference for use during the development of the Detailed Construction Schedule.

- B. Submit eight (8) hard copies and two (2) electronic file copies each on an individual USB thumb drive of the interim Construction Schedule.

3.2 DETAILED CONSTRUCTION SCHEDULE

- A. The CONTRACTOR shall provide eight (8) hard copies and two (2) electronic file copies each on an individual USB thumb drives of the Detailed Construction Schedule submittal due within thirty (30) calendar days after the date of the Notice to Proceed. This submittal shall reflect the entire scope of the Work as awarded.
- B. The CONTRACTOR'S Detailed Construction Schedule shall bear the CONTRACTOR'S stamp of approval signed by the CONTRACTOR. The CONTRACTOR'S stamp of approval shall constitute a representation to the OWNER and CONSTRUCTION MANAGER that the CONTRACTOR has determined or verified all data on that CONTRACTOR'S Construction Schedule or assumes full responsibility for doing so, and that the CONTRACTOR has reviewed and coordinated the sequences in that CONTRACTOR'S Detailed Construction Schedule with the requirements of the Work.
- C. The CONSTRUCTION MANAGER shall review and return the Detailed Construction Schedule Submittal to the CONTRACTOR within fifteen (15) working days. One (1) copy of the CONTRACTOR'S Detailed Construction Schedule will be returned to the CONTRACTOR with comments.
- D. The CONSTRUCTION MANAGER review and comments shall be for conformance with the contract time and those sequences of Work indicated in or required by the Contract Documents, to record early and late dates for milestones, and for conformance with the requirements of this Section and other information given in the Contract Documents which may have a bearing on the schedule. The CONSTRUCTION MANAGER'S review will also be for reasonableness and consistency in the cost loading of the schedule activities. The CONSTRUCTION MANAGER'S review shall not extend to the CONTRACTOR'S means, methods, or techniques, the correctness of which shall remain the sole responsibility of the CONTRACTOR.
- E. If a resubmittal is required, the CONTRACTOR shall make appropriate adjustments or corrections in the CONTRACTOR'S Detailed Construction Schedule returned as "Revise and Resubmit," and shall deliver to the CONSTRUCTION MANAGER four (4) stamped and signed copies of the resubmitted CONTRACTOR'S Construction Schedule directing specific attention, in writing, to adjustments or corrections made other than those made in response to the CONSTRUCTION MANAGER'S comments on the previous submittal. The CONSTRUCTION MANAGER shall review and return one (1) copy of the resubmittal within ten (10) working days. Acceptance of the Detailed Construction Schedule by the CONSTRUCTION MANAGER shall be a condition precedent to processing the Applications for payment, after the first full month following return of the original submittal review comments.

3.3 CONTRACTOR'S CONSTRUCTION SCHEDULE UPDATES

- A. Schedule Update Submittals.
 - 1. Schedule Update Submittals are due monthly and consist of the schedule update, cost and resource reports, activity reports, 60-day look-ahead and schedule narrative. Receipt and approval of a Schedule Update Submittal by the CONSTRUCTION

MANAGER will be a condition precedent to processing each Application for Payment.

2. Each Schedule Update Submittal shall consist of four (4) hard copies of all schedules and reports and two (2) electronic copies of the CPM file each on an individual USB thumb drive.
3. Neither the updating of the CONTRACTOR'S Construction Schedule nor the updating of any report or schedule submitted to the CONSTRUCTION MANAGER by the CONTRACTOR under this Section, shall have the effect of amending or modifying, in any way, the contract time, contract completion date, or contract milestone dates.
4. The CONSTRUCTION MANAGER and the CONTRACTOR will agree on an updating method for physical progress of the different activities, Options include quantities installed, man-hours spent, milestones reached, unit measurements (accomplished) and percent of Work completed.

B. Monthly Reviews:

1. Monthly review meetings between the CONSTRUCTION MANAGER and the CONTRACTOR shall be held within an agreed upon time, prior to the end of each month. The purpose of this meeting is to review current month actual schedule data against field and submittal records, evaluate actual physical progress and make recommendations as to payment for Work performed, review the schedule status, identify problem areas, address critical issues, determine causes for delay and formulate recommendations for corrective action.
2. The monthly review meetings shall be held on the same day for each succeeding month, as agreed upon by the CONSTRUCTION MANAGER and CONTRACTOR.
3. The CONTRACTOR shall make appropriate revisions in the Schedule Update. Submittals as may be required at the meeting, and shall include the updated schedule with the CONTRACTOR'S submittal of the Application for Payment within five (5) days from the date of the monthly meeting.
4. The CONTRACTOR shall provide the following to support each monthly review:
 - a. The complete time scaled CPM network for the project including the base line and current construction schedules.
 - b. Bar Charts for near term window (60 working days) showing baseline and current activities.
 - c. Schedule or activity reports sorted by activity number and total float.
 - d. Logic report sorted by activity number, indicating predecessors, and successors.
 - e. Cost and resource plots.
 - f. Written Narrative explaining the progress highlight, problem areas, and the reasons for any logic, duration and critical path modification.
 - g. A sub network analysis showing the impacts due to any delay or disruption identified in the written narrative.

C. Schedule Recovery:

1. Within ten (10) working days after a Schedule Update submittal and having the schedule reflecting negative float the CONTRACTOR shall submit a written recovery statement to the CONSTRUCTION MANAGER describing the cause of the problem and the actions planned by the CONTRACTOR to recover schedule. The CONTRACTOR shall promptly undertake appropriate action at no additional cost to the OWNER to recover schedule whenever the current schedule shows that the CONTRACTOR did not/cannot achieve a milestone established on the Construction Schedule.

2. Appropriate recovery actions may include, but not be limited to, assignment of additional labor, subcontractors, equipment, shift or overtime work, expediting of submittal or deliveries, or any combination of them. Overlapping of activities or sequencing changes to increase concurrence, shall be deemed appropriate only if properly substantiated in the submittal. Recovery plans that require a change in the baseline schedule must be handled as a schedule revision in accordance with Paragraph 3.5, below. The CONTRACTOR shall pay for all costs that the OWNER incurs (additional inspection, etc.) as a result of these overtime shifts.

D. Lack of Action:

1. The CONTRACTOR'S refusal, failure or neglect to take appropriate recovery action or to submit a written recovery statement shall constitute reasonable evidence that the CONTRACTOR is not prosecuting the Work, or separable part, with the diligence that will insure its completion within the applicable contract time. Such lack of action shall constitute sufficient basis for the CONSTRUCTION MANAGER to recommend the withholding of some or all of any payment due, and/or shall be considered ground for termination by the OWNER.

3.4 SCHEDULE REVISIONS

- A. The CONTRACTOR'S Construction Schedule must be revised when it is no longer useful as a status and control mechanism as determined by the CONSTRUCTION MANAGER or when a Change Order impacts the CONTRACTOR'S timing and sequence of the Work.

Contract time (including all contracted milestones) cannot be changed without a formal Change Order approved by the OWNER.

- B. All schedule revisions must be reviewed and approved by the CONSTRUCTION MANAGER. Scheduling of changes is the responsibility of the CONTRACTOR. The CONTRACTOR shall identify all changes arising from a Change Order and submit the revised CONTRACTOR'S Construction Schedule to the CONSTRUCTION MANAGER for review and approval. The CONTRACTOR shall provide a separate sub-network schedule for each Change Order showing the revised activities, whether the change is concurrent or sequential, the duration of the change and the restraints on pricing of the change. Failure to provide the sub-network schedule in a timely manner will result in the CONTRACTOR waiving his right for additional time. No time will be granted under the contract for the cumulative effect of changes.

- C. The CONTRACTOR shall submit to the CONSTRUCTION MANAGER, eight (8) copies and two (2) copies on two (2) USB thumb drives of the CONTRACTOR'S Construction Schedule revision which shall bear the CONTRACTOR'S stamp of approval, signed by the CONTRACTOR. The CONSTRUCTION MANAGER'S review shall be for the same items identified for the review of the Construction Schedule Submittal, as well as to identify the CONTRACTOR'S use of float. The correctness of the CONTRACTOR'S Construction Schedule revision shall remain the sole responsibility of the CONTRACTOR.

All Schedule revisions must include a written narrative describing the reason for the revision, the revised critical path and all logic and duration revisions. The reasons shall include, but not be limited to, changes in the Specifications, extra work, addition or

deletion of work, increased or decreased quantities, defective work and acceleration of the work.

END OF SECTION 013200

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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 Conditions of Volume 1, “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 fifteen (15) days after the date of Notice to Proceed or at the preconstruction conference, the Contractor shall submit a preliminary schedule of values in accordance with Section 013110 – Schedule of Values.

Subsequent requirements to submit a detailed Schedule of Values and any further revisions shall also comply with the requirements of Section 013110.

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 Authority) of each submittal unless otherwise indicated.
 - 2. Informational Submittals: Submit one (1) electronic copy and/or one (1) hard copy (if requested by the Authority) 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 013550 – SECURITY

PART 1 - GENERAL

1.1 SUMMARY

- A. Protect the active construction areas of the Work, including all material, equipment, field office trailers, and their contents from theft, vandalism, and unauthorized entry.
- B. Contractor is responsible for securing the site, including installing and maintaining temporary security fence to protect the project site, existing treatment plant/facilities, and other work/storage areas.

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.

1.3 RELATED SECTIONS

- A. Section 015000 - Temporary Facilities and Controls
- B. Section 015600– Project Environmental Controls

1.4 SUBMITTALS

- A. Prior to performance of any work at the Project Site, submit to Engineer for record only, two copies of the security plan commensurate with the needs of the Project, signed by officer of Contractor. Contractor to be solely responsible for adequacy of the security plan.
- B. Provide Engineer and Owner/Operators with drawing and data showing temporary fencing and gate locations, along with materials to be used.
- C. Provide Engineer and Owner with a list of 24-hour emergency phone numbers for Contractor personnel.
- D. Submit to Engineer and Owner an updated progressive inventory of materials and equipment received on-site.
- E. Submit log of workmen and visitors to Project Site.

1.5 SECURITY PROGRAM

- A. Protect Work and existing premises, including the field office trailers and their contents, from theft, vandalism, and unauthorized entry during working and non-working hours.
- B. Accept sole responsibility for Project Site security and protection of the Work.

- C. Initiate the security program at job mobilization and maintain the security program throughout construction period.
- D. Limit lighting to basic safety and security requirements, and shield when possible.
- E. Be responsible for the security of storage compound and lay down area, and for all plant material, equipment, and tools at all times.
- F. Prohibit firearms for the Project Site.
- G. Prohibit dogs from the Project Site, with the exception of those clearly used for security purposes within fenced areas.
- H. Erect and maintain temporary security fencing as required to protect the Work, the Project Site, and existing facilities on the Project Site. The location of all temporary security fencing shall be approved in advance by Engineer.
 - 1. Fence Height: 6 feet
 - 2. Fence Material: Galvanized Steel

1.6 ENTRY CONTROL

- A. Entry control shall not unreasonably limit the personnel of Owner, Engineer, and their operations and maintenance groups from performing assigned duties. Temporary access limitations will be identified to Engineer and the operations and maintenance groups at least 24 hours prior to such limitation.
- B. Restrict entry of unauthorized persons and vehicles into Project Site and allow entry only to authorized persons with proper identification.
- C. Maintain a log of workmen and visitors and make log available to Owner on request. This log shall be submitted to Engineer biweekly or as necessary.
- D. Require all visitors to sign the visitor log acknowledgment of the project rules included in this Section. A copy of the project rules shall be given to each visitor. Submit copies of these forms to Engineer biweekly. Give jobsite security orientation training to all affected employees, including subcontractor employees. Employee participation in the security orientation shall be acknowledged by their respective individual signatures affixed to an orientation roster.
- E. Contractor has the right to refuse access to the Project Site or require that a person or vehicle be removed from the Project Site if found violating any of the project rules.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013550

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. 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. Testing services provided by Owner, if any, are for the sole benefit of Owner. However, test results shall be available to Contractor. It is the Contractor's responsibility to schedule the testing provided by such agencies. Testing necessary to satisfy Contractor's internal quality control procedures shall be the sole responsibility of Contractor.
- 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.
 - 3. Testing Services furnished by Owner: Unless otherwise specified, Owner will provide quality control testing services in connection with the following materials and equipment incorporated in the Work;
 - a. Concrete strength tests.
 - b. Moisture-density and relative density tests on embankment, fill, and backfill materials.
 - c. In-place field density test on embankments, fills, and backfill.
 - d. Other materials and equipment as specified herein.
 - e. Testing, including sampling, shall be performed by Engineer or testing firm's laboratory personnel, in general manner and frequency indicated in the Specifications.
 - f. Furnish all sample materials and cooperate in the testing activities, including sampling. Interrupt the Work when necessary to allow testing, including sampling to be performed. There shall be no claim for an increase in Contract Price or Contract Times due to such interruption. When testing activities, including sampling, are performed in the field by the testing firm's laboratory personnel, furnish personnel and facilities to assist in the activities.

- 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. Concrete materials and mix designs.
 - b. Embankment, fill, and backfill materials.
 - c. Quality control testing of all precast concrete.
 - d. All other tests and engineering data required for Engineer's review of materials and equipment proposed to be used in the Work.
 - e. In addition, the following quality control tests shall be performed by Contractor:
 - 1) Holiday testing of pipeline coatings.
 - 2) Air testing of field-welded joints for steel pipe or pipe cylinders and fabricated specials.
 - 3) All testing and inspection of welding work including, but not limited to, welding procedure qualifications, welder operator qualifications, all work performed by the certified welding inspector, all appropriate nondestructive testing of welds and all repair and retest of weld defects.

1.8 The testing firm's laboratory shall perform all laboratory tests within a reasonable time consistent with the specified standards and will furnish a written report of each test. Distribution of the reports shall be as directed by Engineer.

- 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.
- B. 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.
- C. 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.
- D. 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.

E. 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.

F. 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.

1.9 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.

1.3 SUMMARY OF PERMITS OBTAINED BY OWNER

- A. Owner is not responsible for obtaining any permits.

1.4 NPDES PERMIT

A copy of the District's NPDES permit is available to the Contractor upon request. The plant must comply with these 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.

END OF SECTION 014120

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SECTION 014200 – ABBREVIATIONS 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": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean and similar operations at Project site.
- 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 California Building Code (CBC) of the International Code Council (ICC). The 2016 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. Applicable Standard Specifications: The Contractor shall construct the Work specified herein in accordance with the requirements of the Contract Documents and the referenced portions of those referenced codes, standards and specifications listed herein.
- H. 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.

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. Code 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.
1. DIN- Deutsches Institut für Normung e. V.; www.din.de.
 2. IAPMO – International Association of Plumbing and Mechanical Officials; www.iapmo.org.
 3. ICC – International Code Council; www.iccsafe.org.
 4. ICC-ES – ICC Evaluation Service, LLC; www.icc-es.org.

D. 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.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeial Convention; www.usp.org.
USPS - United States Postal Service; www.usps.com.

END OF SECTION 014200

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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. Section 020960 "Temporary Bypass Pumping Systems"
 - 3. 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 the requirements listed in paragraph 2.4 of this section.
- 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".

2.4 INSPECTOR'S FIELD OFFICE REQUIREMENTS

- A. The Contractor shall maintain ownership and responsibility for maintenance of the trailer from installation until removal from the site. Contractor shall install and have trailer ready for use by Owner within 8 weeks of Notice to Proceed, but prior to commencing work. Contractor shall provide full warranty for the complete duration of the project for the trailer, equipment, and furnishings against failure, leakage, or breakdown. Contractor shall remove the trailer and furnishings from the site after final acceptance by Owner of project completion. Contractor shall provide all labor for installation and removal of the Field Office.
- B. The field office shall meet the following requirements:
 - 1. Construction: Weather-tight trailer, installed level, with blocking, tie-downs, wheels for subsequent moving, and skirts.
 - 2. The trailer shall be located as directed by Owner.
 - 3. Contractor to provide proper drainage and all necessary utilities.
 - 4. Walls and Ceiling: Insulated with finished interior surfaces.
 - 5. Thermostatically controlled heating, ventilating, and air conditioning equipment suitable for maintaining a comfortable work environment (approximately 72 degrees F with ambient temperature varying from 30 degrees F to 120 degrees F).
 - 6. Flooring: Vinyl tile.
 - 7. Security guard screens and blinds on the windows.
 - 8. Exterior lighting over entrance doors.
 - 9. Fluorescent ceiling lights throughout the trailer.

10. 110 volts AC duplex receptacles.
11. Provide railed stairways and railed wood landings. Provide rain-tight solid roof cover over landings.
12. Provide telephone jacks in the conference room and in each office.
13. Provide temporary, portable unisex restroom facilities (hereafter "Portable Toilet") with sink and hot and cold potable water, situated immediately adjacent to the Field Office for exclusive use by Owner representatives. Portable Toilet door shall be equipped with lock and key.

C. Contractor shall furnish and pay for following services for the Field Office:

1. Janitorial service, including weekly dusting, floor cleaning, and trash removal, and monthly comprehensive cleaning (including windows).
2. Electric wiring, power, and lighting fixtures capable of providing at least 75-foot candles of light on work surfaces.
3. Bottled drinking water service with hot- and cold-water dispenser.
4. Provide 480VAC, 3 phase power and step-down transformer (480VAC, 3 phase to 120/240VAC single phase) and lighting panel with circuit breakers suitably sized to supply electrical loads for Field Office.
5. A continuous supply of toilet paper, paper hand towels, paper toilet seat covers, and hand soap for Portable Toilet.
6. Maintenance/janitorial service of Portable Toilet, including weekly removal and disposal of waste, refuse, and trash, and weekly cleaning of interior surfaces and sink.

D. Contractor shall provide high-speed internet access for the Field Office (trailer), including necessary data service and hardware. Contractor shall coordinate with the telephone company for high-speed internet service. As an alternative, Contractor may provide high-speed wireless internet access (air cards).

E. Office and furnishings shall be new, manufactured within 12 months of installation. Contractor to provide following furnishings and office equipment:

1. Obtain and pay for a service contract with a local facsimile, computer, printer, and copier service representative to perform onsite service and repair throughout the project period.

F. Provide all necessary toner, ink, and other materials required for proper operation of the facsimile, printer, and copier. Owner will furnish paper for its use.

G. Remove temporary buildings and furnishings before inspection for Final Completion or when directed by Owner. The Contractor shall remove the Field Office and associated furnishings after acceptance of Final Completion by Owner.

1. Clean and repair damage caused by installation or use of temporary facilities.
2. Remove underground installations to minimum depth of 24 inches below grade and finish grade to match surrounding conditions.
3. Restore existing facilities used during construction to specified or original condition.
4. Restore existing facilities affected by temporary facilities, including temporary Field Office and associated utilities to pre-construction conditions.

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.
 - 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: The Owner's telephone system shall not be used by the Contractor's work force.
 - 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 non-tracking. Reapply treatment as required to minimize dust.
 4. All SWPPP requirements and plans must be met and provided, including along temporary/non-paved roadways.
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction and coordinate with the LGVSD managers and staff.
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: Parking at and near the project area is limited and will not be available for the Contractor's personnel. **Contractor shall arrange for personnel parking outside of the plant's premises.**
- 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. Project Signs: Provide Project sign. Unauthorized signs are not permitted.
1. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 2. Maintain and touchup signs so they are legible at all times.
- G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction.
- H. 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.
- I. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
 - J. 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.
 - K. 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 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. Where required, existing improvements shall be protected with shoring, sheeting, piles, or other necessary means.
- 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. The Contractor shall notify the Owner's representative of any change of condition or extra work as soon as it is discovered, including any damage to existing facilities, pipelines and improvements not designated for removal. The Contractor shall also notify the Owner's representative of any plans to relocate existing piping or facilities to accommodate new construction.
- D. 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.
- E. Buried pipelines, utilities, conduits, duct banks, or other improvements that must remain in service and are exposed due to excavation or construction activities shall be protected and supported as required. Segments of pipelines or duct that is suspended over excavated areas shall be temporarily supported until they can be properly backfilled. All temporary support strategies shall be reviewed and approved by Owner and Engineer.
- F. 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. All restoration shall be at the Contractor's expense.

1.4 UNDERGROUND UTILITIES

- A. All care shall be exercised to protect existing underground utilities during construction activity. This site has very limited access and will likely require heavy equipment to be operated above existing buried utilities. The contractor shall protect these pipelines (existing and new) from heavy vehicle loads and ensure that cranes or other heavy outrigging equipment is not parked or stored directly above these utilities without added protection.
- B. 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 the Contract (Article 6 – Changes and Extra Work).

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 SUMMARY

- A. The following sections include mitigation measures to be integrated into the LGVSD Secondary Treatment Plant Upgrade and RW Expansion project to reduce the potentially environmental impacts resulting from the construction activities. The Contractor shall implement mitigation measures identified below during the construction process, as well as any other measures required in these documents, on the design drawings, and as required by other local, state, and federal agencies.

1.2 WATER QUALITY

- A. NPDES Construction Activity Stormwater Permit. Contractor shall comply with the provisions of the NPDES Construction Activity Stormwater permit, including preparation of Notice of Intent to comply with the provisions of this General Permit and preparation of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP will identify implementation measures necessary to mitigate potential water quality degradation as a result of construction-related runoff. These measures will include BMPs and other standard pollution prevention actions, such as erosion and sediment control measures, proper control of non-stormwater discharges, and hazardous spill prevention and response. The SWPPP will also include requirements for BMP inspections, monitoring, and maintenance.
- B. The following items are examples of BMPs that would be implemented during construction to avoid causing water quality degradation:
 - 1. Erosion control BMPs, such as use of mulches or hydroseeding to prevent detachment of soil, following guidance presented in the California BMP Handbooks – Construction (CASQA 2003). A detailed site map will be included in the SWPPP outlining specific areas where soil disturbance may occur, and drainage patterns associated with excavation and grading activities. In addition, the SWPPP will provide plans and details for the BMPs to be implemented prior, during, and after construction to prevent erosion of exposed soils and to treat sediments before they are transported offsite.
 - 2. Sediment control BMPs such as silt fencing or detention basins that trap soil particles.
 - 3. Construction staging areas designed so that stormwater runoff during construction will be collected and treated in a detention basin or other appropriate structure.
 - 4. Management of hazardous materials and wastes to prevent spills.
 - 5. Groundwater treatment BMPs such that localized trench dewatering does not impact surface water quality.
 - 6. Vehicle and equipment fueling BMPs such that these activities occur only in designated staging areas with appropriate spill controls.
 - 7. Maintenance checks of equipment and vehicles to prevent spills or leaks of liquids of any kind.

1.3 AIR QUALITY

- A. Construction Fugitive Dust Control Plan: Contractor shall prepare, submit for review and approval, and implement a dust control plan that conforms to the local requirements. The dust control plan shall include the following dust control procedures, or others as required the local authority:
1. Water all active construction areas at least twice daily, taking into consideration temperature and wind conditions.
 2. Cover all trucks hauling soil, sand, and other loose materials or require trucks to maintain at least two feet of freeboard.
 3. Pave, apply water three times daily, or apply (non-toxic) soil stabilizers on unpaved access roads, parking areas and staging areas at construction sites.
 4. Sweep daily (with water sweepers) all paved access roads, parking areas and staging areas at construction sites.
 5. Sweep streets daily (with water sweepers) if visible soil material is carried onto adjacent public streets.
 6. Hydroseed or apply (non-toxic) soil stabilizers to inactive construction areas (previously graded areas inactive for ten days or more).
 7. Enclose, cover, water twice daily or apply (non-toxic) soil binders to exposed stockpiles (dirt, sand, etc.)
 8. Limit traffic speeds on unpaved roads to 5 mph.
 9. Install sandbags or other erosion control measures to prevent silt runoff to public roadways, consistent with Mitigation Measures for Erosion Control.
 10. Replant vegetation in disturbed areas as quickly as possible.
 11. Contractor may use onsite treated effluent for dust abatement. Coordinate access and allowable volumes with Owner.
- B. Construction Exhaust Emissions Control Plan: Contractor shall implement an exhaust emissions control plan that shall include the following controls and practices:
1. On road vehicles with a gross vehicular weight rating of 10,000 pounds or greater shall not idle for longer than five minutes at any location as required by Section 2485 of Title 13, Division 3, Chapter 10, Article 1 of the California Code of Regulations. This restriction does not apply when vehicles remain motionless during traffic or when vehicles are queuing.
 2. Off road equipment engines shall not idle for longer than five minutes per Section 2449(d)(3) of Title 13, Division 3, Chapter 9, Article 4.8 of the California Code of Regulations. All vehicle operators shall receive a written idling policy to inform them of idling restrictions. The policy shall list exceptions to this rule that include the following: idling when queuing; idling to verify that the vehicle is in safe operating condition; idling for testing, servicing, repairing or diagnostic purposes; idling necessary to accomplish work for which the vehicle was designed (such as operating a crane); idling required to bring the machine to operating temperature as specified by the manufacturer; and idling necessary to ensure safe operation of the vehicle.
 3. Off road engines greater than 50 horsepower shall, at a minimum, meet Tier 2 emissions standards. When available, higher Tier engines shall be utilized.

1.4 NOISE

- A. Contractor shall develop, submit for review and approval, and implement a Construction Noise Reduction Plan that requires, at a minimum, the following:
1. The contractor shall locate all stationary noise-generating equipment, including hammer bore and drill rigs, as far as possible from nearby noise-sensitive receptors. Stationary noise sources located within 500 feet of noise-sensitive receptors shall be equipped with noise reducing engine housings, and the line of sight between such sources and nearby sensitive receptors shall be blocked by portable acoustic barriers.
 2. The contractor shall assure that construction equipment with internal combustion engines have sound control devices at least as effective as those provided by the original equipment manufacturer. No equipment shall be permitted to have an un-muffled exhaust.
 3. All construction activities within unincorporated areas shall be limited to between the hours depending upon the jurisdiction.
 4. Construction equipment including compressors, generators, and mobile equipment shall be fitted with properly working mufflers.
 5. Residences and other sensitive receptors within 200 feet of a construction area shall be notified of the construction schedule in writing, at least two weeks prior to the commencement of construction activities. This notice shall indicate the allowable hours of construction activities as specified by the applicable local jurisdiction or as defined by this mitigation measure. The Owner shall designate a noise disturbance coordinator who would be responsible for responding to complaints regarding construction noise. The coordinator shall determine the cause of the complaint and ensure that reasonable measures are implemented to correct the problem. A contact number for the noise disturbance coordinator shall be conspicuously placed on construction site fences and entrances by the contractor and included in the construction schedule notification sent to nearby residences and sensitive receptors.

1.5 HAZARDS AND HAZARDOUS MATERIALS

- A. In the event that evidence of potential soil contamination such as soil discoloration, noxious odors, debris, or buried storage containers, is encountered during construction, the contractor will have a contingency plan for sampling and analysis of potentially hazardous substances, including use of a photoionization detector. The required handling, storage, and disposal methods shall depend on the types and concentrations of chemicals identified in the soil. Any site investigations or remediation shall comply with applicable laws and will coordinate with the appropriate regulatory agencies.
- B. If unknown USTs are discovered during construction, the UST, associated piping, and impacted soil shall be removed by a licensed and experienced UST removal contractor. The UST and contaminated soil shall be removed in compliance with applicable county and state requirements governing UST removal.
- C. Contractor shall prepare, submit for review and approval, and implement a project-specific Health and Safety Plan that would apply to excavation activities. The plan shall establish policies and procedures to protect workers and the public from potential hazards posed by hazardous materials. The plan shall be prepared according to federal and California OSHA regulations and submitted to the appropriate agency with jurisdiction prior to beginning site

activities. The health and safety plan shall also be submitted to the District for review and approval.

- D. Consistent with the SWPPP requirements, the construction contractor shall be required to implement BMPs for handling hazardous materials onsite. The use of construction BMPs will minimize any adverse effects on groundwater and soils, and will include, but not limited to, the following:
 - 1. Follow manufacturers' recommendations and regulatory requirements for use, storage, and disposal of chemical products and hazardous materials used in construction;
 - 2. Spill control and countermeasures, including employee spill prevention/response training;
 - 3. Avoid overtopping construction equipment fuel gas tanks;
 - 4. During routine maintenance of construction equipment, properly contain and remove grease and oils; and
 - 5. Properly dispose of discarded containers of fuels and other chemicals.
- E. The contractor shall follow the provisions of California Code of Regulations, Title 8, Sections 5163 through 5167 for General Industry Safety Orders to protect the project area from being contaminated by the accidental release of any hazardous materials and/or wastes. The local Certified Unified Program Agency (CUPA) will be contacted for any site-specific requirements regarding hazardous materials or hazardous waste containment or handling.
- F. Oil and other solvents used during maintenance of construction equipment shall be recycled or disposed of in accordance with applicable regulatory requirements. All hazardous materials shall be transported handled, and disposed of in accordance with applicable regulatory requirements.
- G. In the event of an accidental release of hazardous materials during construction, containment and clean up shall occur in accordance with applicable regulatory requirements.
- H. Contractor shall prepare, submit for review and approval, and implement a Fire Safety Plan for each of the service areas associated with the project. The Fire Safety Plan(s) will describe various potential scenarios and action plans in the event of a fire.
- I. During project construction, all staging areas, welding areas, or areas slated for development using spark-producing equipment will be cleared of dried vegetation or other material that could ignite. Any construction equipment that includes a spark arrestor shall be equipped with a spark arrestor in good working order. All vehicles and crews working at the project site(s) will have access to functional fire extinguishers at all times. In addition, construction crews will be required to have a spotter during welding activities to look out for potentially dangerous situations, including accidental sparks.

1.6 CULTURAL RESOURCES

- A. Inadvertent Discoveries: If discovery is made of items of historical or archaeological interest, the contractor shall immediately cease all work activities in the area (within approximately 100 feet) of discovery. Prehistoric archaeological materials might include obsidian and chert flaked-stone tools (e.g., projectile points, knives, scrapers) or toolmaking debris; culturally darkened soil ("midden") containing heat-affected rocks, artifacts, or shellfish remains; and stone milling equipment (e.g., mortars, pestles, handstones, or milling slabs); and battered stone tools, such as

hammerstones and pitted stones. Historic-period materials might include stone, concrete, or adobe footings and walls; filled wells or privies; and deposits of metal, glass, and/or ceramic refuse. After cessation of excavation the contractor shall immediately contact the NBWRA and the Authority. The contractor shall not resume work until authorization is received from the Authority.

1. In the event of unanticipated discovery of archaeological indicators during construction, the Authority shall retain the services of a qualified professional archaeologist to evaluate the significance of the items prior to resuming any activities that could impact the site.
2. In the case of an unanticipated archaeological discovery, if it is determined that the find is unique under the National Historic Preservation Act (NHPA) and/or potentially eligible for listing in the National Register, and the site cannot be avoided, the Authority shall provide a research design and excavation plan, prepared by an archaeologist, outlining recovery of the resource, analysis, and reporting of the find. The research design and excavation plan shall be submitted to NBWRA and the Authority and approved by the Authority prior to construction being resumed.

- B. Discovery of Human Remains: If potential human remains are encountered, the Authority shall halt work in the vicinity of the find and contact the county coroner in accordance with Public Resources Code Section 5097.98 and Health and Safety Code Section 7050.5. If the coroner determines the remains are Native American, the coroner shall contact the Native American Heritage Commission (NAHC). As provided in Public Resources Code Section 5097.98, the NAHC shall identify the person or persons believed to be most likely descended from the deceased Native American. The most likely descendent makes recommendations for means of treating or disposing of, with appropriate dignity, the human remains and any associated grave goods as provided in Public Resources Code Section 5097.98.

1.7 EXPLOSIVES AND BLASTING:

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

1.8 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.

END OF SECTION 015600

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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. For products listed as "NO EQUAL", contractor must furnish products from the named supplier including the listed make and mode. Note that specifics of the make and model may be altered as recommended by the manufacturer or engineer to better suite the application. However substitutes from a different manufacturer are not allowed.
 - 2. For products listed as "APPROVED EQUAL", contractor must furnish products from the named supplier unless prior approval form Owner AND Engineer is provided prior to bid opening. Contractor must submit information from the proposed alternate supplier sufficient to prove that the alternate equipment is equal to (or better than) the listed equipment. Owner and Engineer may approve or reject alternates at their sole discretion

in alignment with maintaining the best interest of the District and project. Any approved alternates must be stated as such in writing from the Engineer.

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 General Conditions.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016100

SECTION 016600 – EQUIPMENT TESTING AND PLANT STARTUP

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 and conformance with all requirements of "Commissioning" per section 017500. 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, "Contractor Submittals".

B. Owner Selected Equipment

1. The Contractor shall notify the Engineer when Owner selected equipment (if any) is completely installed in accordance with the Owner selected manufacturer's instructions and requirements of the Contract Documents and ready for operational testing and "Commissioning" per section 017500. The Contractor 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 in accordance with requirements of section 017500 "Commissioning".
- 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. Section 024100 "Demolition, Salvage, and Reconstruction" for disposition of waste resulting from demolition of buildings, structures, and site improvements.
 - 2. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.
 - 3. 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. Hazardous waste shall be removed, handled, and properly disposed by a Contractor licensed and trained in the proper handling and disposal of each type of waste encountered on the site.
- B. While every effort has been made to identify hazardous materials ahead of time, the Contractor may encounter unanticipated hazardous materials during the course of construction or demolition. If such materials are encountered (or it is suspected that an unidentified material may be hazardous), Contractor shall immediately notify Owner and staff to discuss the appropriate course of action.

END OF SECTION 017419

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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 is not limited to the Functional Acceptance Test (FATC) 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 LGVSD’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 LGVSD 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 409000 – Instrumentation Control 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 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 (FATC): The FATC 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 FATC 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 LGVSD 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: The Contractor may apply for Substantial Completion after the Engineer has accepted all Reliability Acceptance Tests (RATs) and the Contractor have submitted all Manufacturers' Certificates of Proper Installation. Also, see Division 1 - General Requirements.
- 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 California or a currently licensed grade 5 wastewater treatment operator in the state of California.
- H. Owner: Owner is defined as the Las Gallinas Valley Sanitary District (LGVSD). 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. Table 1 illustrates some of the tasks.
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 (FATC). The purpose of the FATC 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 (see General Conditions for definition).

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 LGVSD 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 the 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

the 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, FATCs and RATs to conduct the testing. Sample templates for ORT, FATC 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, FATC and RAT schedules.
7. Show all operations and maintenance training classes.
8. The Contractor shall include in the commissioning schedule adequate for complete testing of automation, including creating a wide range of process conditions (normal and out of range), and repeats to allow for system tuning. The cases where variables are “forced” shall be minimized, and process planning and adequate schedule are necessary to do so.

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 FATC 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 LGVSD 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 LGVSD personnel for electrical equipment shall be completed.
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 FATC 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. FATC – Functional Acceptance Test – The FATC 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 ensure 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 FATC 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. The first group of systems to come on line together is the Primary Pump Station, modified Primary Biofilter, and

- Electrical Building. Other test systems groups are listed in Table 2. 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. 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 is 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, FATC 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. Perform Local Manual Mode Tests.
7. Piping Equipment is Complete and Pressure Tested.
8. Pipe Supports Complete.
9. Pipe is Clean of Debris (inside and out).
10. Verify Valve Operation and Positions for Commissioning.
11. SCADA System is Complete and Energized.
12. Perform Wiring and Loop Tests.
13. PLC Programming Complete.
14. Perform Electrical Power System Energization Test (EPSET).
15. Perform Operational Readiness Test.
16. Pre-commissioning Requirements.

C. Commissioning

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

**TABLE 1
PRE-COMMISSIONING AND COMMISSIONING**

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

TABLE 2		
RELIABILITY ACCEPTANCE TEST PARAMETERS		
SYSTEM	TEST DURATION	NOTES
Group #1	7 continuous days without a problem	All systems included in Group #1 must start simultaneously. Each system must have its own startup plan and separate RAT documentation.
Sludge Storage Mixer		
Sludge Storage Discharge Pumps		

EXHIBIT 1

COMMISSIONING DOCUMENT SAMPLES

OPERATIONAL READINESS TEST (ORT)

FUNCTIONAL ACCEPTANCE TEST PROCEDURE (FATC)

SAMPLE RELIABILITY ACCEPTANCE TEST PROCEDURE (RAT)

OPERATIONAL READINESS TEST
LAS GALLINAS VALLEY SANITARY DISTRICT
TWAS ENCLOSURE & SLUDGE STORAGE

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

Signature or comments for non-
 acceptance(Owners Rep)

Step	ok Contractor	ok Sub	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 (FATC)			

FUNCTIONAL ACCEPTANCE TEST PROCEDURE (FATC)

1.1 OVERVIEW

- A. The purpose of the Functional Acceptance Test (FATC) 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 FATC is a combined effort between Contractor and Owner. The tests will require coordination with Operations to ensure normal processing is not disrupted. A LGVSD 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 FATC. 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 LGVSD will be corrected by the LGVSD. 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 FATC procedure, prepared by the Commissioning Coordinator, to the Owner for approval. The Owner's approval of the procedure prior to the start of the FATC 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 FATC 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 FATC.
- 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 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 FATC:
 - 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
SLUDGE STORAGE DISCHARGE PUMPS**

#	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		
Pump 1 63-P-1100 (Typical for pumps)			
1	Open discharge plug valve 63-V-1113	Pumps should not operate unless the discharge valves are open.	
2	Temperature switch TSH-63-1100 and other safety relays for the pump should be installed and their connectivity/operation verified	Pumps must not operate without temperature switch and other safety devices in place.	
3	Verify proper operation of wet well influent and associated HS instrumentation	Level instruments and mixer in wet well should be installed and operational.	
4	Verify proper operation of level instruments LT-2100 and LSL-2100	Verify the level instruments operate as intended.	
5	Verify downstream flow meter 63-M-2200.	Flow meter should be calibrated to verify pump flow.	
5	Discharge pressure transmitter PT-63-1100 should be installed and operational.	Pressure transmitter (and local display) should verify pumps operating pressure.	
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 up	
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)

PRIMARY PUMP STATION

1.1 OVERVIEW

- A. The RAT for the Primary Pump Station will involve other areas or systems that must start simultaneously; they are listed in Table 2 Reliability Acceptance Test Parameters. 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 (FATC) 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. 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.

1.3 PROCEDURE

- A. Prior to beginning the Primary Pump Station RAT, all of the related systems must be ready for their own RAT. They include the following systems: The areas are also listed in Table 2 Group #1. The contractor with the approval of the Owner may modify this list of related areas.
- B. All ORT's and the FATC 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 Sludge Storage Basin Discharge Pumps Station is provided below.

SLUDGE STORAGE PUMP DISCHARGE PUMP STATION STARTUP ACTIVITY		
1.	Verify completion of ORT's and FATC.	
2.	Verify the Owner has approved the RAT procedure.	
3.	Verify all downstream systems are ready to accept flow. (See Table 2 Group #1 for a list of related systems.)	
4.	Startup meeting with Owner, Plant Operators, Commissioning Coordinator and Engineer reviewing the startup plan.	
Primary Pump Station		
	After sludge pumps 63-P-1100, and 63-P-1200, are operating and proven reliable the RAT can commence.	
1.	Open the appropriate pump isolation valves.	
2.	Ensure digesters are ready to receive flow.	
3.	Ensure mixer 63-ME-3100 is operational.	
4.	Ensure level sensors in sludge storage basin are online and reading correctly.	
5.	Energize pumps.	
6.	Set the HOA switch for Pumps to Auto.	
7.	Open the appropriate valves to allow flow into the sludge storage basin.	
8.	Verify the operation of the pump station.	
9.	Verify the flow meter is reading.	
10.	Verify pressure transducers are reading.	
11.	Start the clock for the RAT.	

DOCUMENTATION

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

PRIMARY PUMP STATION 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, 63-P-1100										
Pump 2, 63-P-1200										
Level Sensor LT-63-2100										
Level Alarm Low/ LSL-63-2100										
Magnetic Flow Meter 63-M-2200										
Mixer 63-ME-3100										
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 "Commissioning" 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.
1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

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 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

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SECTION 018110 - SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

- A. This section Includes seismic design criteria for the following:
1. Anchorage of mechanical and electrical equipment and piping.
 2. Seismic design of tanks and anchorage of tanks.
 3. Other structures or items as specified or indicated on the Drawings.

1.2 REFERENCES

- A. International Code Council (ICC) documents as follows:

CBC California Building Code, 2019 Edition

- B. American Society of Civil Engineers (ASCE) documents as follows:

ASCE 7 Minimum Design Loads for Buildings and Other Structures, 2010 Edition

1.3 SUBMITTALS

- A. Shop Drawings and Calculations: Submit shop drawings and structural calculations in accordance with Section 013300 – Contractor Submittals. All drawings and calculations shall be signed and sealed by a licensed Civil or Structural engineer as required below under “Qualifications.”
- B. ICC-ES reports for concrete anchors.

1.4 QUALITY ASSURANCE

- A. Qualifications
1. Licensed Professionals: Design of items required by this Section and other items not specifically shown in the Contract Documents shall be performed by a Structural Engineer licensed to practice in the state of California.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Design Criteria: Design in accordance with the requirements of the California Building Code and ASCE 7.
1. Seismic acceleration variables to be used in design are as shown in the Drawings.
 2. Seismic Importance Factor for Anchorage of Mechanical and Electrical Equipment: 1.50.
 3. Seismic Importance Factor for the Design of Tanks and the Anchorage of Tanks: 1.50.
 4. Do not use friction to resist sliding due to seismic forces.

5. Use only headed anchor bolts, adhesive anchors, or welded studs for anchors resisting seismic forces. Embedded anchor bolts used to resist seismic forces shall have a standard hex bolt head.
 - a. Adhesive anchors must have current ICC-ES reports showing that the anchors meet CBC requirements when installed in cracked substrates.
 - b. Do not use other types of anchors unless indicated on the Drawings or approved in writing by Engineer.
 - c. Seismic forces must be resisted by direct bearing on the fasteners used to resist seismic forces. Do not use connections which use friction to resist seismic forces.

PART 3 - EXECUTION

Not Used

END OF SECTION 018110

SECTION 018211 - WIND DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

- A. This section Includes design criteria for the following when exposed to wind forces:
1. Anchorage of mechanical and electrical equipment and piping.
 2. Design of tanks and anchorage of tanks.
 3. Other structures or items as specified or indicated on the Drawings.

1.2 REFERENCES

- A. International Code Council (ICC) documents as follows:

CBC California Building Code, 2019 Edition.

- B. American Society of Civil Engineers (ASCE) documents as follows:

ASCE 7 Minimum Design Loads for Buildings and Other Structures, 2010 Edition

1.3 SUBMITTALS

- A. Shop Drawings and Calculations: Submit shop drawings and structural calculations in accordance with Section 013300 – Contractor Submittals Procedures. All drawings and calculations shall be signed and sealed by a licensed Structural engineer as required below under “Qualifications.”
- B. ICC-ES reports for concrete anchors.

1.4 QUALITY ASSURANCE

- A. Qualifications

1. Licensed Professionals: Design of items not specifically shown in the Contract Documents shall be performed by a professional Structural Engineer licensed to practice in the state of California.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Design Criteria: Design in accordance with the requirements of the California Building Code, ASCE 7 and in accordance with design criteria indicated in the drawings.
1. Use only headed anchor bolts, adhesive anchors, or welded studs for anchors resisting wind forces. Embedded anchor bolts used to resist wind forces shall have a standard hex bolt head.
 - a. Adhesive anchors must have current ICC-ES reports showing that the anchors meet CBC requirements.
 - b. Do not use other types of anchors unless indicated on the Drawings or approved in writing by the Engineer.

- c. Wind forces must be resisted by direct bearing on the fasteners used to resist wind forces.

PART 3 - EXECUTION

Not Used

END OF SECTION 018211

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 if this and any additional bypass pumping associated with the project work will be required.
- 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

- A. FOR OVERFLOW AND SPILLS: 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.
- B. Contractor is responsible to obtain air permits if diesel pumps are to be utilized.

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.

LGVSD
 TWAS ENCLOSURE & SLUDGE STORAGE

TEMPORARY BYPASS PUMPING SYSTEMS
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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.
- I. For pipelines or hoses that are above ground and/or cross roadways or other traffic areas:
 - 1. Route of above ground pipeline/hose must be approved by Engineer and operating staff.
 - 2. For any pipeline or hose that crosses a roadway above ground, contractor shall furnish suitable firehose bridge or hose/pipeline ramp across the entire intersection of the pipe with the roadway. The ramp or bridge must be minimum H-20 traffic rated, and suitable to handle all traffic that will cross the bridge for the duration of its installation. Temporary piping/hose and ramps shall be removed by the contractor when bypassing pumping operation ceases.

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. Contractor is responsible to obtain air permit for diesel pumps.
- 3. Pumps shall be capable of variable flow to accommodate the cyclical nature of influent flows to the plant. Minimum 50% turn down of pump's max capacity is anticipated.
- 4. 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. Bypass pumping is not anticipated to be required for this work. However, certain conditions such as time of year, weather, operating parameters, or other unforeseen circumstances may result in bypass pumping being required or advisable to ensure proper operation of the active wastewater treatment plant. Accordingly, if circumstances dictate, bypass plans and requirements should be coordinated with operators and the engineer at that time.
- 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

3.1 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.

3.2 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.

3.3 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 020960

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SECTION 024100 - DEMOLITION, SALVAGE, AND RECONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall demolish, salvage and reconstruct existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.
- B. Certain existing structures and piping have been inspected and identified as containing hazardous materials including asbestos and lead paint. Demolition, rehabilitation, or other activity that may include the removal or disturbance of hazardous materials at these locations shall be properly handled and disposed of by a contractor trained and licensed for the removal and disposal of said materials as identified in the Pre-Demolition Asbestos and Lead Survey Report. A copy of this report is available from the District upon request.

1.2 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. 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 COORDINATION AND PROJECT CONDITIONS

- A. The Contractor shall carefully coordinate the Work in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The Work as indicated is not all inclusive, and the Contractor shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The Contractor shall comply with sequencing requirements in Section 011000 – Summary of Work.
- B. The Contractor shall note that the Drawings used to indicate demolition and reconstruction are based on record drawings of the existing facilities. Prior to bidding, the Contractor shall conduct a comprehensive survey at the Site to verify the scope of Work, and the extent of auxiliary utilities. A partial set of record drawings is available for review from the Owner.
- C. Buildings and/or structures to be demolished will be vacated and their use discontinued before start of the demolition.
- D. 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.

E. Hazardous Materials:

1. While every effort has been made to identify hazardous materials that will be exposed/impacted due to this project, some areas not identified in the above-mentioned report may contain as yet unknown or identified hazardous materials. Accordingly, if any materials suspected of containing hazardous materials are encountered beyond what is identified in the report, the contractor shall **not disturb said materials and shall immediately notify the Engineer and Owner**. Unidentified hazardous materials will be removed by Owner under a separate contract or negotiated with Contractor via change order.

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

G. Arrange demolition schedule so as not to interfere with Owner's operations at the adjacent WRF.

H. While demolition and reconstruction are being performed, the Contractor shall provide adequate access for the continued operation and maintenance of equipment and treatment processes at the existing WWTP. The Contractor shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the Contractor's employees and the Owner's personnel. The Contractor shall remove such protection when reconstruction activities are complete, or as work progresses, or when directed by the Engineer.

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 CONTRACTOR SUBMITTALS

A. Demolition and reconstruction activities and procedures, including operational sequence, shall be submitted to the Engineer for approval. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation. A storage plan for salvaged items shall be included.

1.6 DEMOLITION AND ABANDONMENT

A. Existing pavement, concrete, retaining walls, curb and gutter, sidewalks, buildings, yard structures, equipment, piping, valves, ductwork, duct banks, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the Work shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the Contractor.

1.7 SALVAGE

- A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated in the drawings to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled and protected on the Site at a location directed by the Engineer. The Contractor shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling.

1.8 RELOCATION

- A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances required to be relocated and/or salvaged shall be removed without any degradation in condition from that prior to removal. The Contractor shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

1.9 REHABILITATION

- A. Existing WWTP site shall be restored and landscaped as noted in the drawings.

1.10 DISPOSAL

- A. The Contractor shall be responsible for the legal, offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 - PRODUCTS (NOT USED)

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 GENERAL

- A. The Contractor shall coordinate demolition and reconstruction Work with the Owner and Engineer. Unless otherwise indicated, the Contractor shall be responsible for the sequence of activities. Work shall be performed in accordance with applicable safety rules and regulations.
- B. The Contractor shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction. The Owner shall arrange the shutoff of indicated utilities when requested by the Contractor.

- C. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the Work activities to the extent indicated. If reconstruction beyond the scope indicated is required, the Contractor shall obtain approval from the Engineer prior to commencing.

3.3 PROTECTION OF EXISTING FACILITIES

- A. Before beginning any reconstruction, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to demolition shall be protected and maintained in accordance with Section 015300 – Protection of Existing Facilities. Damaged existing facilities shall be repaired to the previous condition or replaced.
- B. Persons shall be afforded safe passages around areas of demolition.
- C. Erect a plainly visible fence around drip line of individual trees or around the perimeter drip line of groups of trees to remain.
- D. Provide temporary barricades and other protection required to prevent injury to people and adjacent buildings and facilities to remain.
- E. Provide protection to ensure safe passage of people around demolition areas.
- F. Structural elements shall not be overloaded. The Contractor shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of Work performed under this Section. The Contractor shall remove temporary protection when the Work is complete or when so authorized by the Engineer.
- G. The Contractor shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment or material.
- H. The Contractor shall not destroy any permanent survey points without the consent and review of the District. Any permanent monuments or points destroyed shall be replaced by a licensed land surveyor who is licensed in the State of California. Replacement shall be at the Contractor's expense.
- I. All valve boxes, catch basins, manholes, and vaults that are to remain in service shall be adjusted to new grade to coordinate with final grade or pavement.

3.4 DEMOLITION, SALVAGE, AND RELOCATION

- A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The Contractor shall verify the scope of the Work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 011000 – Summary of Work. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:

1. Demolish indicated buildings/structures and site improvements completely. Use methods required to complete the Work within limitations of governing regulations.
2. Equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Damage to the existing structure shall be repaired as indicated.
3. Exposed piping including vents, drains, and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2-inches. Resultant openings in the structure shall be repaired as indicated.
4. Electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.
5. Exposed electrical conduits and associated wiring shall be removed. Resultant openings in structures shall be repaired as indicated.
6. Connections to embedded electrical conduits shall be removed a minimum of 2-inches inside the finished surface of the existing structure. Wiring shall be removed and the resulting openings shall be repaired as indicated.
7. Associated instrumentation devices shall be removed.
8. Auxiliary utility support systems shall be removed.
9. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.
10. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.
11. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed completely.
12. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 312000 – Earth Moving. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.
13. When existing pipe is removed, the Contractor shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug.
14. When existing piping is removed from existing structures, the Contractor shall fill resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or indicated. In locations where the surface of the grout will be exposed to view, the grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.
15. Electrical reconstruction shall be conducted by the Contractor in a safe and proper manner to avoid injury from electrical shock to the Owner's and Contractor's personnel. Electrical equipment to be shut off for a period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections, which are energized or could become energized be accessible to Contractor, Owner, or other personnel without suitable protection or warning signs.

- B. The Contractor shall perform, in the presence of Owner, an initial and final inspection of existing equipment that will be relocated to ensure the equipment condition is maintained as documented during the initial inspection. The Contractor shall make repairs and modifications necessary to restore the equipment to its original condition at no additional cost to the Owner.

3.5 ABANDONMENT

- A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the Contractor shall completely remove the abandoned pipe to the points indicated on the plans. For abandoned segments that connect into active segments to remain, piping shall be removed to the connection point, and stubbed and capped at the connection point.
- B. Where removal is deemed unfeasible, the contractor may abandon in place after receiving permission from Owner. In this case, abandoned pipe shall be removed for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inches diameter or greater shall be completely sand-filled prior to closure of the piping ends.
- C. Where abandoned underground structures are encountered, the contractor shall remove the abandoned structures to sufficient depth to allow for new underground lines to cross or for new structures/foundations. Extent of removal shall be coordinated with Owner.

3.6 REHABILITATION

- A. Certain areas of existing structures, piping, conduits, and the like will be affected by Work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by its construction activities.
- B. Where new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as indicated or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to provide watertightness around openings so formed. The boxes or cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.
- C. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4-inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouted casings shall then be water cured.
- D. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.
- E. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.
- F. Where existing handrailing is removed, post embedments and anchors shall be removed and post holes shall be filled with non-shrink grout flush to the floor surface. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system

shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.

- G. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated in accordance with Section 09 90 00 – Painting and Coating to match the original painting and coating with a compatible system.

3.7 DISPOSAL

- A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities, which shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.
- B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.
- C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.8 OCCUPANCY AND POLLUTION CONTROL

- A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The Contractor shall comply with government regulations pertaining to environmental protection.
- B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.9 CLEANING

- A. During and upon completion of Work, the Contractor shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by Work in a clean, approved condition.
- B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as directed by the Engineer or governing authorities, and adjacent areas shall be returned to condition existing prior to start of Work.

3.10 STRUCTURES IDENTIFIED AS CONTAINING HAZARDOUS MATERIALS

- A. The following is a summary of the full findings provided in the hazardous assessment report. Refer to the full report in Appendix B of the Volume 3 appendix for more information. This list is provided for reference and convenience only – the Contractor is responsible for properly handling hazardous material-bearing structures as listed and identified in the report.
- B. The following structures/sites near the proposed project area were identified as asbestos-containing materials. Per the report the list is not exhaustive and complete as it only summarizes areas that were actually tested. Suspect materials that are similar in appearance/type to those testing positive

for asbestos must be presumed to be asbestos-containing unless they are tested and proven not to contain asbestos.

1. MCC #3 Building – Cementitious panels (i.e. Transite® panels) and floor tiles; reference sheets MBS-1 thru MBS-3.
2. Other gaskets and caulking of similar age and appearance will also like contain similar levels of asbestos and should be handled as such.

C. Lead-containing coatings were identified in most surfaces tested for the report and, **per the report, the testing results are not exhaustive and complete as they only summarize areas that were directly sampled and tested.** Materials/coatings containing lead include interior walls/ceilings, doors/frames, storage containers, most painted piping (especially older, beige colored piping), process and water storage tanks, concrete structure protective coatings (walls, slabs, and floors), steel structural members and supports, pumps/motor housings. Below is a summary of areas that tested positive for lead-containing paints – refer to the report for complete results and sample locations.

1. MCC #3 Building (door frame/trim, door, walls - reference sheet MBS-1)
2. RWTF UV piping (reference sheet RUV-1)

D. Suspect materials that are similar in appearance/type to those testing positive for lead must be presumed to be lead-containing unless they are tested and proven not to contain lead. Refer to Appendix A of the report for sample locations and Appendix C of the report for a complete list of results and areas that tested positive for lead.

END OF SECTION 024100

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
- C. Concrete Formwork. 031000
- D. Concrete Unit Masonry. 042000

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS:

A. Codes:

The Building Code, as referenced herein, shall be the latest California Building Code (CBC).

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)

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 of 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

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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 polyvinylchloride 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:

<u>Physical Property, Sheet Material</u>	<u>Value</u>	<u>ASTM Test Method</u>
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
 <u>Accelerated Aging (CRD-C572)</u>		
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:

<u>Physical Property</u>	<u>Value</u>	<u>ASTM TEST Method</u>
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 groove 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 California Building Code (CBC), Section 1905, but shall not be less than one set per day, nor less than one set for each 50 cu yds of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls.
- 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 be 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 2.9, 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 established position in plan.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.
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 alkalis. The term "alkalies" is defined as the sum sodium oxide (Na₂O), potassium oxide (K₂O), calculated as sodium oxide (.658 K₂O). 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 F resulting 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.

2.6 SHEET VAPOR RETARDER

- A. Provide under building slabs and/or mat foundations. ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 1. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.
 2. Vaporblock VB10, by Raven Industries,
 3. Or Equal.

2.7 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/cm² at 72 hours as measured by ASTM C156. Curing compound shall comply with Federal, State, and local VOC limits.

2.8 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.

2.9 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. $R = (\text{CaO} - 5\%)/(\text{Fe}_2\text{O}_3)$, 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 0.50.

- D. Proportion normal-weight concrete mixture as follows:

- 1. Minimum Compressive Strength: 5000 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: Structural Concrete

- 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.

2.10 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 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.

2.12 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.

2.13 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.

2.14 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 $\frac{1}{4}$ and $\frac{3}{4}$ 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 OF 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 laitance, 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 of 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 embedments 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 overall 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 embedments 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

	<u>< 12-in</u>	<u>12 to 36-in</u>
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

<u>Forms for</u>	<u>Degree Days</u>
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. Formed concrete surfaces inside buildings and machine rooms and all exposed exterior surfaces of foundations, basins, vaults, hydraulic structures and curbs.
 2. 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.
 3. 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.
 4. Cork-Float 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.
- 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 unlevelled, 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

<u>Area</u>	<u>Finish</u>
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 14 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:

<u>Material</u>	<u>Volumes</u>	<u>Weights</u>
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 in proportions 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 re-

quired 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 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 Surfacing and Polymer Concrete.
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing 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 051200 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.

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 – 13th 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- and masonry-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- and masonry-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 Engineer free access to the work. Notify the Engineer 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 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Composite Floor Steel deck.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Evaluation reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.2 FLOOR DECK

- 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. Verco Decking - Nucor Corp.; Vulcraft Group.
 2. Or Equal
- B. Floor Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS).
 2. Deck Profile: Verco "B" Formlok
 3. Profile Depth: As indicated Drawings
 4. Design Uncoated-Steel Thickness: As indicated.

2.3 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- G. Galvanizing Repair Paint: ASTM A 780.
- H. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

- B. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- C. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- F. Welds to supporting members and the method of sidelap attachment are to be as per the structural drawings.
- G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- H. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions. Installers using powder-actuated shall be properly trained and experienced in the use of such equipment.
- I. Miscellaneous Deck Accessories: Install, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- J. Pour Stops and Girder Fillers: Weld steel-sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.
- K. Floor-Deck Closures: Weld steel-sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Engineer.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.3 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

END OF SECTION 053100

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 metallurgically 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 and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. 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 055000

SECTION 056500 – METAL BUILDING WALL PANELS

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish metal wall panels in colors and styles to match existing improvements at the site where indicated in the design drawings. These wall panels may be part of a pre-engineered metal building or serve to enclose other structures.

1.02 REFERENCES

- A. AISI - Specification for the Design of Cold-Formed Steel Structural Members - 1986 Edition with 1989 Addendum.
- B. AISC - Specification for Structural Steel Buildings - 1989.
- C. AISC - Steel Design Guide Series 3 - Serviceability Design Considerations for Low-Rise Building - 1990.
- D. ASTM A36 - Specification for Structural Steel.
- E. ASTM A 53 - Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
- G. ASTM A325-04b - Specification for High Strength Bolts for Structural Steel Joints.
- H. ASTM A123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- I. ASTM A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical Quality).
- J. ASTM A463 - Specification for Steel Sheet Cold Rolled Aluminum Coated Type 1 and Type 2.
- K. ASTM A490 - Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints.
- L. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- M. ASTM A501 - Hot Formed Welded and Seamless Carbon Steel Structural Tubing.
- N. ASTM A529 - Structural Steel with 50,000 psi Minimum Yield Point.
- O. ASTM A570 - Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality.
- P. ASTM A572 - Specification for High Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality.
- Q. ASTM A792 - Specification for Steel Sheet Aluminum Zinc Alloy Coated by the Hot Dip Process, General Requirements.
- R. ASTM E1514 - Specification for Structural Standing Seam Steel Roof Panel Systems.

- S. AWS A2.4-93 - Standard Welding Symbols.
- T. AWS D1.1-96 - Structural Welding Code - Steel.
- U. AWS D1.3-89 - Structural Welding Code - Sheet Steel.
- V. MBMA Low Rise Building Systems Manual - 2002 Edition.

1.03 SUBMITTALS

- A. Contractor shall submit building drawings and calculations in accordance with Section 01300 Contractor Submittals. The submittals shall include details describing the R-panels used in construction, color samples, and a description of all other structural and architectural components required to complete the installation of the panels.

1.04 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with MBMA Low Rise Building systems Manual, and, for items not covered, AISC - Specification for Structural Steel for Buildings. Metal Building Manufacturer shall be AISC Certified Category MB.

1.05 FIELD MEASUREMENTS

- A. Contractor shall verify that field measurements are as indicated on drawings.

1.06 WARRANTY

- A. Panel manufacturer shall provide a Panel Finish Limited Warranty of twenty (20) years.

PART 2 - PRODUCTS

2.01 MATERIALS - WALL SYSTEMS

- A. Wall Panels Description:
 - 1. Wall panels shall have 1-1/4 inch trapezoidal ribs spaced 12 inches on center and two stiffener ribs. Each panel shall provide 36" net coverage in width.
 - 2. The panels shall be attached to the girts per the manufacturer's recommendations
 - 3. All wall panels shall be continuous from sill to roof line except where lengths become prohibitive for handling purposes. All end-laps shall be at least 4".
- B. Wall Panel Material: Sheet Steel Stock: Panel material shall be aluminum-zinc alloy-coated steel conforming to ASTM A792 for coating AZ50 or AZ55.
 - 1. 26-gauge or 24-gauge coated steel shall have a minimum yield strength of 80,000 PSI in accordance with ASTM A-792.
- C. Closures at the eaves and rake and where panels end over or under a door, window, louver or other such wall openings, the wall panel corrugations shall be filled with pre-formed closed cell, laminated polyethylene foam closure when required for weather tightness.

- D. Fasteners self-drilling, self tapping, HWH 410 stainless steel screws with sealing washers through flat of panel if “R” type panel or through rib if “A” type panel. Size to maintain load and weather tightness requirements.

2.02 PANEL FINISH

- A. Exterior Finish: panels shall be finished to meet or exceed the following criteria:
 - 1. Prime coat: The base metal shall be pretreated and primed with epoxy or urethane type primer for superior adhesion and superior resistance to corrosion. The dry film thickness shall be 0.2 mils.
 - 2. Final coating for exterior metal wall and roof panels shall be factory-applied, oven-baked finish coat of Kynar 500®/ Hylar 5000 ® coil-coated smooth finish high-content fluorocarbon coatings for excellent color retention, corrosion resistance and durability.
 - 3. Excellent weatherability and resistance to coating deterioration shall be evident when subjected to the following tests:
 - a. Humidity Resistance: Immediately after removal from cabinet, the exposed area shall contain less than 5% No. 8 blisters, after 1000 hours when tested according to ASTM D-2247.
 - b. Salt Spray Resistance: Immediately after removal from cabinet, the exposed area shall contain less than 5% No. 8 blisters, after 750 hours when tested according to ASTM B-117.
 - c. Specular Gloss: The gloss rating shall be 25-35 degrees on a Gardner 60 degree gloss meter when tested in accordance with ASTM 523.
 - d. Hardness: The coating shall have a minimum paint hardness of F-2H using Eagle Turquoise drawing pencils.
 - e. Q.U.V. Weatherometer: There shall be no objectionable color change, chalking or blistering after 300 hours when tested in accordance with ASTM G-53
- B. Interior Finish: shall match the exterior finish unless noted otherwise in the finish schedule.
- C. Color Selection: Exterior panel and trim colors will be selected from the Building Manufacturer’s standard colors. Submit two (2) color charts with the proposal, must be approved by Owner, **and conform to the restrictions listed in Section 01560 – Environmental controls regarding exterior building colors and aesthetics.**
- D. All fasteners, anchors, bolts, and other mounting hardware shall consist of 316 stainless steel.

2.03 MATERIALS - TRIM

- A. Exterior gutters shall be 24-gauge, G90 galvanized steel with the same finish as the wall panels. Color to be chosen by Owner from manufacturer provided color charts.
- B. Downspouts shall be 28-gauge G90 galvanized steel with a color coordinated, pre-painted finish. Color to be chosen by Owner from manufacturer provided color charts.
- C. Standard rake trim shall be 26-gauge, G90 galvanized steel with the same finish as the wall panels. Color to be chosen by Owner from manufacturer provided color charts. If the roof is a Standing Seam or Loc-Seam system, the rake shall be attached to the endwall material with a slip joint, allowing the rake to expand and contract with the roof system.

- D. Wall trim shall be 26-gauge, G90 galvanized steel with the same finish as the wall panels. Color to be chosen by Owner from manufacturer provided color charts.
- E. All gutter and downspout joints, rake flashing laps, ridge flashing laps doors, windows and louvers shall be sealed with Sika Sikaflex 201 caulk or equal. The caulk shall meet or exceed the requirements of Federal Specification TT-S-00230C, Type II, Class A.

PART 3 - EXECUTION

3.01 RECEIVING, STORAGE AND HANDLING OF MATERIALS ON JOBSITE

- A. All materials shall be unloaded, handled, hauled and delivered to storage by competent workmen in a manner, which will prevent bends, dents, scratches and other damage. Damaged materials shall be rejected and promptly replaced. All materials shall be properly stored and protected from weather damage by the Contractor. All shipments will be thoroughly checked by the project Contractor.
- B. Primed Materials: Upon receipt, all bundles of primed material shall be stored on blocking at an angle sufficient to allow any trapped water to drain and should be protected from the weather by covers allowing air circulation. Water, ice and snow should not be allowed to collect and remain thereon.
- C. Bundles of panels shall be inspected for moisture upon receipt. If moisture is present, dry the panels and, if possible, store them in a warm, dry place. The panel bundles shall be elevated and sloped in a manner to allow moisture to drain. Cover all bundles with a tarp or plastic, leaving airspaces for adequate air circulation.

3.02 ERECTION – GENERAL

- A. The erection of the panels and the installation of accessories will be performed in accordance with the Manufacturer's erection drawings and erection manuals by a qualified installer using proper tools, equipment and safety practices.
- B. Install in accordance with manufacturer's instructions
- C. Exercise care when cutting prefinished material to ensure cuttings do not remain on finish surface.
- D. Fasten cladding system to structural supports, aligned level and plumb.

3.03 TOLERANCES

- A. All work shall be performed in a workmanlike manner.
- B. Install Framing in accordance with MBMA Low Rise Building Systems Manual, Common Industry Practices.

END OF SECTION 056500

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured reglets with counterflashing.
2. Formed roof-drainage sheet metal fabrications.
3. Formed low-slope roof sheet metal fabrications.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Distinguish between shop- and field-assembled work.
3. Include identification of finish for each item.
4. Include pattern of seams and details of termination points, expansion joints and expansion-joint covers, direction of expansion, roof-penetration flashing, and connections to adjoining work.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

- ##### A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are SPRI ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

1.6 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:
 1. Design Pressure: As indicated on Drawings.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 coating designation or aluminum-zinc alloy-coated steel sheet according to ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; prepainted by coil-coating process to comply with ASTM A 755/A 755M.
 1. Surface: Mill phosphatized for field painting.
 2. Exposed Coil-Coated Finish:
 - a. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 3. Color: As selected by Owner from manufacturer's full range.

2.3 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.
- B. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F; and complying with physical requirements of ASTM D 226/D 226M for Type I and Type II felts.
- C. Self-Adhering, High-Temperature Sheet: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.
 - 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F or higher.
 - 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.
- D. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
 - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - 2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel.
- C. Solder:
 - 1. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

- E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 - 1. Obtain field measurements for accurate fit before shop fabrication.
 - 2. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 - 3. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- C. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- E. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- F. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

- H. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- long sections. Furnish flat-stock gutter brackets and gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.
- B. Downspouts: Fabricate downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors
 - 1. Fabricate from the following materials:
 - a. Aluminum: 0.024 inch thick.
- C. Parapet Scuppers: Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4-inch- wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fabricate from the following materials:
 - 1. Aluminum: 0.032 inch thick.
- D. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes. Fabricate from the following materials:
 - 1. Aluminum: 0.032 inch thick.
- E. Splash Pans: Fabricate to dimensions and shape required and from the following materials:
 - 1. Aluminum: 0.040 inch thick.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch- long, but not exceeding 12-foot- long sections. Furnish with 6-inch- wide, joint cover plates. Shop fabricate interior and exterior corners.
 - 1. Fabricate from the Following Materials:
 - a. Aluminum: 0.050 inch thick.
- B. Copings: Fabricate in minimum 96-inch- long, but not exceeding 12-foot- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, solder or weld watertight. Shop fabricate interior and exterior corners.
 - 1. Fabricate from the Following Materials:
 - a. Galvanized Steel: 0.040 inch thick.
- C. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Galvanized Steel: 0.028 inch thick.
- D. Counterflashing and Flashing Receivers: Fabricate from the following materials:
1. Galvanized Steel: 0.022 inch thick.
- E. Roof-Penetration Flashing: Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch thick.
- F. Roof-Drain Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.016 inch thick.

PART 3 - EXECUTION

3.1 UNDERLAYMENT INSTALLATION

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.
- B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
- C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days.

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, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 2. 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.
 3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.

4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
 5. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
1. Do not solder metallic-coated steel and aluminum sheet.
 2. Do not use torches for soldering.
 3. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
 4. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
 5. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.
- H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.3 ROOF-DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.
- B. Hanging Gutters: Join sections with riveted and soldered joints. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.
 - 1. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.
- C. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c.
- D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in asphalt roofing cement or elastomeric sealant compatible with the substrate.
- E. Parapet Scuppers: Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
- F. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch below scupper or gutter discharge.
- G. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints minimum of 4 inches in direction of water flow.

3.4 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches 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 over base flashing. Lap counterflashing joints minimum of 4 inches.

- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric or butyl sealant and clamp flashing to pipes that penetrate roof.

3.5 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.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION 076200

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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 4 Section "Concrete Unit Masonry" for masonry control and expansion joint fillers and gaskets.
 - 2. Division 8 Section "Glazing" for glazing sealants.
 - 3. Division 9 Section "Gypsum Board Assemblies" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.
 - 4. Division 9 Section "Ceramic Tile" for sealing tile joints.

5. Division 9 Section "Acoustical Panel Ceilings" for sealing edge moldings at perimeters of acoustical ceilings.

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. 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.
- C. 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 or design Engineer.
 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.
- D. 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: Pecora Corporation; AC-20+.
 1. Sonneborn, Division of ChemRex Inc.; Sonolac.
 2. 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 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 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 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 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 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 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 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 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 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 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 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 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 from manufacturer's full range.

END OF SECTION 079200

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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 082210

SECTION 083323 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Overhead coiling service doors.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
2. Show locations of controls, locking devices, detectors or replaceable fusible links, and other accessories.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 or UL 10B.

1. Temperature-Rise Limit: At exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
 - 1. Design Wind Load: Uniform pressure (velocity pressure) of 40 lbf/sq. ft., acting inward and outward.
 - 2. Testing: According to ASTM E 330.
 - 3. Large-Missile Test: For overhead coiling doors located within 30 feet of grade.
- B. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 DOOR ASSEMBLY

- A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
 - 1. Manufacturers: Doors shall be as manufactured by one of the following:
 - a. Kinnear Corp.
 - b. Overhead Door Corp.
 - c. Pacific Rolling Door Co.
 - d. Or Equal.
- B. Operation Cycles: Door components and operators capable of operating for not less than 20,000.
- C. Curtain R-Value: 7 deg F x h x sq. ft./Btu minimum.
- D. Door Curtain Material: Galvanized steel.
- E. Door Curtain Slats: Flat profile slats of 3-1/4-inch center-to-center height.
 - 1. Insulated-Slat Interior Facing: Metal.
- F. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from hot-dip galvanized steel stainless steel and finished to match door.
- G. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.
- H. Hood: Match curtain material and finish.
 - 1. Mounting: Face of wall.
- I. Locking Devices: Equip door with slide bolt for padlock.
- J. Manual Door Operator: Chain-hoist operator.
- K. Electric Door Operator:

1. Usage Classification: Heavy duty, 25 or more cycles per hour and over 90 cycles per day.
2. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.
3. Motor Type: TEFC.
4. Emergency Manual Operation: Push-up type.
5. Obstruction-Detection Device: Automatic photoelectric sensor.
6. Control Station(s): NEMA 4X.

L. Curtain Accessories: Equip door with weatherseals and push/pull handles.

M. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Color as selected by Owner from manufacturer's full range.
2. Interior Curtain-Slat Facing: Finish as selected by Owner from manufacturer's full range.

2.3 MATERIALS, GENERAL

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.

2.4 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Vision-Panel Glazing: Manufacturer's standard clear glazing, fabricated from transparent acrylic sheet or fire-protection rated glass as required for type of door; set in glazing channel secured to curtain slats.
2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84 or UL 723. Enclose insulation completely within slat faces.
3. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.5 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and

bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
2. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

2.6 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
- B. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.7 CURTAIN ACCESSORIES

- A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.
- B. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
- C. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

2.8 COUNTERBALANCING MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Brackets: Manufacturer's standard mounting brackets of hot dipped galvanized steel.

2.9 MANUAL DOOR OPERATORS

- A. General: Equip door with manual door operator by door manufacturer.
- B. Push-up Door Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf.

- C. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25-lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

2.10 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Motors: Reversible-type motor for motor exposure indicated.
 - 1. Electrical Characteristics:
 - a. Phase: Single phase.
 - b. Volts: 115 V.
 - c. Hertz: 60.
 - 2. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 - 3. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
- D. Obstruction Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.
 - 1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.
 - 2. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

- a. Self-Monitoring Type: Four-wire configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.
- 3. Pneumatic Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device.
- E. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
 - 1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 4X enclosure.
- F. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.
- G. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- H. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- I. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Fire-Rated Doors: Install according to NFPA 80.
- C. Power-Operated Doors: Install according to UL 325.
- D. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Lubricate bearings and sliding parts as recommended by manufacturer. Adjust seals to provide tight fit around entire perimeter.
- E. Contractor is responsible for coordinating requirements for mounting door to structure at installation location including necessary secondary members, fasteners, support rails, etc.. required to install a complete, weather-resistant installation compatible with the building and opening.

3.2 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 083323

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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. Corbin Russwin
 - b. Schlage Commercial Lock Division; an Ingersoll-Rand company.
 - c. 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. Corbin Russwin
 - b. Schlage Commercial Lock Division; an Ingersoll-Rand company.
 - c. 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
 - c. Corbin Russwin

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. Corbin Russwin
 - b. Schlage Commercial Lock Division; an Ingersoll-Rand company.
 - c. 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 087100

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: Clear 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 tempered 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.
 - 3. Fill space between lites with Argon.
 - 4. Low E-Coating: Pyrolytic on second surface.

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 088000

SECTION 098000 - PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and application of coating systems.
1. **System A:** Concrete – Immersion, Non-Potable, Corrosive Environment
 2. **System B:** Concrete – Immersion in Acidic Liquids
 3. **System C:** Concrete – Exposed Reinforcement Protection
 4. **System D:** Concrete – Sealant (Non-Paint Finish)
 5. **System E:** Concrete Masonry Unit (CMU) Sealer – Non-Paint Finish
 6. **System F:** Ferrous Metal – Exterior, Non-Immersion excluding buried surfaces
 7. **System G:** Ferrous Metal – Interior, Non-Immersion excluding buried surfaces
 8. **System H:** Ferrous Metal – Immersion, Non-Potable
 9. **System I:** Galvanized Steel and Non-Ferrous Metal – Non-Immersion
 10. **System J:** Aluminum – Embedded or in contact with concrete
 11. **System K:** Wood – Interior and Exterior
 12. **System L:** PVC Pipe – Exterior and Interior Exposure
 13. **System M:** Buried ferrous metal piping and fittings; miscellaneous surfaces requiring tar epoxy
 14. **System N:** Hot-Dip Galvanizing
 15. **System O:** Wall Board – Water and Light Chemical Exposure
 16. **System P:** Ferrous Metal – Moderate to Severe Chemical Exposure Including H₂S Exposure.
 17. **System Q:** Concrete Floors with moderate chemical exposure.

1.2 DESCRIPTION

- A. 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.

1.3 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
- C. 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.
- D. The Society for Protective Coatings (SSPC):
1. Surface Preparation Specifications:
 - a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
 - b. PA 3, Guide to Safety in Paint Applications.
 - c. SSPC-SP 1, Solvent Cleaning.
 - d. SSPC-SP 2, Hand Tool Cleaning.
 - e. SSPC-SP 3, Power Tool Cleaning.
 - f. SSPC-SP 5, White Metal Blast Cleaning.
 - g. SSPC-SP 6, Commercial Blast Cleaning.
 - h. SSPC-SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
 - i. SSPC-SP 10, Near-White Blast Cleaning.
 - j. SSPC-SP 11, Power Tool Cleaning To Bare Metal.
 - k. SSPC-SP12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating.
 - l. SSPC-SP13, Surface Preparation of Concrete.
 - m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.
- E. NACE International (NDACE): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
- F. National Fire Protection Association (NFPA).
- G. National Sanitation Foundation (NSF).
- H. International Concrete Restoration Institute (ICRI).

1.4 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. The term "exposed" as used in this Section shall mean all items not covered with concrete, masonry, or similar material.

1.5 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. 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.
- C. Color Samples: Manufacturer's standard color charts for color selection by Owner.

D. 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.

E. Applicator Qualifications: Submit qualifications as specified under Quality Assurance article.

F. 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.

1.6 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.

1.7 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. Acceptable Manufacturers:

1. Tnemec Co. (Where noted otherwise in the coating specification use specified product or equal).
2. Sherwin-Williams Company – comparable systems must provide equal or better protection to the Tnemec systems listed below.
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.

1.8 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.

1.9 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.

1.11 PROTECTION OF SURFACES NOT TO BE COATED

- A. Protect surfaces and equipment which are not to receive coatings during surface preparation, cleaning and painting operations.
- B. 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.
- C. 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.

1.12 PROJECT CONDITIONS

- A. Environmental Requirements:

1. Adhere to manufacturer's data on air and surface temperature limits and relative humidity during application and curing of coatings. Note that on some coatings for concrete, applications may be required during declining temperatures only.
 2. Do not spray apply paint when wind velocity is above 15 mph.
 3. Schedule coating work to avoid dust and airborne contaminants.
 4. Apply exterior finishes during daylight hours only.
 5. When painting in confined spaces, or because of unfavorable ambient conditions, longer drying times will be necessary.
 6. Provide supplementary ventilation such as fans and blowers in confined or enclosed areas to carry off solvents during evaporation stage.
- B. Existing Conditions:
1. Broom clean area before painting is started. Remove dirt and dust.
 - a. After painting operations begin, broom cleaning will not be allowed. Clean only with commercial vacuum cleaning equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All paint shall be manufactured by one of the suppliers listed in Paragraph 1.7 F., herein, and shall be their highest grade of paint.
- B. 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 1.7 F., 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.
- C. 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.
- D. Emulsion and alkyd paints shall contain a mildewcide and both the paint and mildewcide shall conform to OSHA and Federal requirements, including Federal specification TT-P-19.
- E. Finish coats containing lead shall not be allowed.
- F. Rags shall be clean painters rags, completely sterilized.

- G. 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 2.3 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 COATING SYSTEMS

General: Where exposures and/or coating are not specified or when two (2) classifications can apply, the worst-case condition shall be used to determine the coating system.

- A. System A: Concrete - Immersion, Non-Potable:
 - 1. Examples of application areas for this system include the following surfaces:
 - a. Interior walls of hydraulic structures with potential for H₂S exposure (e.g. sludge lagoon return pump station).
 - b. Floors and interior surfaces of concrete covers/slabs of hydraulic structures with potential for H₂S exposure.
 - c. Concrete exposed to corrosive environments where System A is noted.
 - d. Other immersed concrete areas where System A is noted.
 - 2. Surface Preparation: All oil, grease, waste and chemical contaminants must be removed from the surface of the concrete prior to preparation in accordance with NACE SP0892 and SSPC-SP13/NACE 6. Surface preparation requirement is to expose a clean, sound, uniform surface texture confirming to the minimum recommended ICRI-CSP5. Existing concrete to receive protective coating system must be sound and capable of supporting the System.
 - 3. Coating System (Use a):

- a. System may be used as self priming and without a topcoat, confirm each application with the manufacturer to ensure proper usage.

Epoxy coating – Themec Series 49 Multi-Purpose Epoxy provide two (2) coats of 8.0 to 10.0 mil per coat. Allow proper cure time between coats.

B. System B: Concrete – Immersion in Acidic Liquids

1. Area of application: Refer to finish schedule for applicable locations.
2. Surface Preparation: All oil, grease, waste and chemical contaminants must be removed from the surface of the concrete prior to preparation in accordance with NACE SP0892 and SSPC-SP13/NACE 6. Surface preparation requirement is to expose a sound, uniform surface texture confirming to the minimum recommended ICRI-CSP5. Existing concrete to receive protective coating system must be sound and capable of supporting the Protective Lining System.
3. Coating System (Use a, b and c):
 - a. Surfer/Filler: The appropriate cementitious repair mortar or epoxy cementitious resurfacer material shall be applied to the entire, prepared surface to level surface suitable for coating.
 - 1) For concrete deteriorated greater than a depth of 1/4-inch: Themec Series 217 Mortarcrete - Trowelable grade, rapid-setting, cementitious repair mortar and when recommended by the Manufacturer to rehabilitate and restore concrete and provide level substrate for application of the protective lining.
 - 2) For new or existing concrete to a depth up to 1/4-inch: Themec Series 218 MortarClad Epoxy cementitious resurfacer shall be used for filling voids, bugholes, static cracks and joints, and for general concrete patching, and to provide a uniform, void free surface for Epoxy Lining application. The Series 218 shall be applied to the entire surface at a minimum thickness of 1/16 inch.
 - b. Epoxy Lining (basecoat): Themec Series 434 Perma-Shield H2S at 125 mils
 - c. Epoxy Lining Glaze Protective Lining (topcoat): Themec Series 435 Perma-Glaze at 15 – 20 mils

C. System C: Exposed Reinforcement Protection

1. Area of Application: Exposed sawcut concrete face and exposed existing reinforcement.
2. Surface Preparation: According to manufacturer's recommendations.
3. Coating: Sika Armatec 110 EpoCem, or equal (Coverage per manufacturer's recommendations. Minimum 20 mil. thickness).

D. System D: Concrete Sealer – Non-Paint Finish

1. Area of application:
 - a. Concrete Floors in the UV Disinfection Building, Electrical Building, etc. per finish schedule.
 - b. Interior Concrete Floors not exposed to weather and corrosion.
2. Surface Preparation:
 - a. Follow manufacturer's recommendations for surface preparation.
3. Product:
 - a. Tnemec CT Densyfier Series 629 at 300 to 350 sf per gallon.

E. System E: Concrete Masonry Unit (CMU) Sealer: Non-Paint Finish

1. Area of application: All exterior and interior masonry, where paint or other coating is not specified in drawings.
2. Surface Preparation:
 - a. Follow manufacturer's recommendations for surface preparation for each type of masonry.
3. Coating:
 - a. Tnemec Prime A Pell H2O series 633 at 50-75 sf per gallon.

F. System F: Ferrous Metal: Exterior, Non-Immersion excluding Buried Surfaces:

1. Exterior metal surfaces that are exposed to the atmosphere but which do not come into contact with water, wastewater, or corrosive atmosphere. Examples of this classification include, but not limited to, the following surfaces:
 - a. Exterior or Above Ground Pipe.
 - b. Piping and valves inside below ground valve vaults.
 - c. Pumps, Motors, Equipment.
 - d. Steel plate and shapes.
 - e. Doors and frames.
2. Surface Preparation:
 - a. For Structural Steel, Equipment, and steel tanks: SSPC-SP6 Commercial Blast Cleaning with a minimum angular profile of 1.5 mils.
 - b. For Ductile or Cast Iron Piping, Valves, Pumps: 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.
3. Coating System
 - a. For Structural Steel, Equipment, and Steel Tanks:

- 1) Primer: Hydro-Zinc Series 94 H20 at 2.5 - 3.5 mils dft
 - 2) Intermediate: Hi-Build Epoxoline II L69 at 3.0 – 5.0 mils dft
 - 3) Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft
- b. For Ductile or Cast Iron Piping, Valves, Pumps:
- 1) Primer: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - 2) Intermediate: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - 3) Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft

G. System G: Ferrous Metal: Interior, Non-Immersion excluding Buried Surfaces:

1. Interior metal surfaces that are exposed to the atmosphere but which do not come into contact with water, wastewater, or corrosive atmosphere. Examples of this classification include, but not limited to, the following surfaces:
 - a. Piping, valves, appurtenances and supports.
 - b. Pumps, Motors, Equipment.
 - c. Exposed surfaces of electric panels, conduit, ventilation fans, etc.
2. Surface Preparation:
 - a. For Structural Steel, Equipment, and steel tanks: SSPC-SP6 Commercial Blast Cleaning with a minimum angular profile of 1.5 mils.
 - b. For Ductile or Cast Iron Piping, Valves, Pumps: 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.
3. Coating System
 - a. For Structural Steel, Equipment, and Steel Tanks:
 - 1) Intermediate: Hi-Build Epoxoline II L69 at 3.0 – 5.0 mils dft
 - 2) Finish: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - b. For Ductile or Cast Iron Piping, Valves, Pumps:
 - 1) Primer: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - 2) Intermediate: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft

H. System H: Ferrous Metal - Immersion, Non-Potable:

1. Examples of this classification include, but not limited to, the following surfaces:
 - a. Pipe.
 - b. Metal surfaces in dry and wet wells or in immediate vicinity of corrosive environments.
 - c. Other submerged or partially submerged ferrous metal.
2. Surface Preparation: SSPC-SP10 Near White Blast Cleaning with a minimum angular anchor profile of 1.5 mils.
3. Coating System:
 - a. Primer: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - b. Intermediate: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft

- c. Finish: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft

I. System I: Galvanized Steel and Non-Ferrous Metal - Non-Immersion:

- 1. Examples of this classification include the following surfaces:
 - a. Galvanized steel pipe where specifically noted or specified.
 - b. Galvanized or zinc-coated steel fabrications where specifically noted or specified.
 - c. Aluminum fabrications where specifically noted or specified.
 - d. Aluminum or other non-ferrous pipe or tubing.
 - e. Copper pipe and tubing.
- 2. 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
- 3. Coating System:
 - a. Primer: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - b. Interior Finish: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - c. Exterior Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft

J. System J: Dissimilar Metal Insulation: Aluminum embedded or in contact with concrete:

- 1. Examples of this classification include the following surfaces:
 - a. Aluminum embedded or in contact with concrete, Stainless steel in contact with Carbon Steel:
 - 1) Portions of slide gate frames.
 - 2) Portions of hatch cover frames.
 - 3) Portions of stair stringers.
 - 4) Portions of grating and floor plate frames.
- 2. 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.
- 3. Coating System:
 - a. Primer: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - b. Intermediate: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - c. Finish: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft

K. System K: Wood - Interior and Exterior:

- 1. Examples of this classification include the following surfaces:
 - a. Wood trim.
 - b. Wood Panels
- 2. Surface Preparation: Sand rough areas. Clean and dry.

- 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

L. System L: PVC/CPVC Pipe

- 1. This classification includes exteriors of exterior and interior PVC/CPVC pipe, valves and accessories
- 2. Surface Preparation: As specified in Paragraph 3.3, herein.
- 3. Coating System:
 - a. Exterior Exposed:
 - 1) Primer: Hi-Build Epoxoline II L69 at 2.0 – 4.0 mils dft
 - 2) Finish: Endura-Shield Series 1095 2.0 to 3.0 mils dft
 - b. Interior Exposed:
 - 1) Primer: Hi-Build Epoxoline II L69 at 2.0 – 4.0 mils dft
 - 2) Finish: Hi-Build Epoxoline II L69 at 2.0 – 4.0 mils dft

M. System M: Buried ferrous metal piping:

- 1. Examples of this classification include the following surfaces:
 - a. Buried steel, ductile iron piping and appurtenances.
- 2. Surface Preparation:
 - a. Steel Surface Preparation: SSSPC-SP10 Near White Blast Cleaning.
 - b. Ductile Iron Surface Preparation: 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.
- 3. Coating System:
 - a. Steel Surface:
 - 1) Primer: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - 2) Intermediate: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - 3) Finish: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - b. Ductile Iron Surface:
 - 1) Primer: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - 2) Intermediate: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - 3) Finish: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft

N. System N: Hot-Dip Galvanizing

- 1. This classification includes but is not limited to stair stringers, grating embeds, fasteners, support members, and interior structural members not epoxy coated per Systems “Ferrous Metal: Interior, Non-Immersion” and “Ferrous Metal - Immersion, Non-Potable”.

2. Surface Preparation: The Fabricator shall remove all welding slag, splatter, anti-splatter compounds and burrs prior to delivery for galvanizing. Avoid unsuitable marking paints. Consult with the galvanizer about removal of grease, oil paint and other deleterious material prior to fabrication. Remove by blast cleaning or other methods surface contaminants and coatings, which would not be removable by the normal chemical cleaning process in the galvanizing operation.
3. Coating System:
 - a. Pre-clean steelwork in accordance with accepted methods to produce an acceptable surface for quality hot-dip galvanizing.
 - b. Galvanize steel members, fabrications, and assemblies after fabrication by the hot dip process in accordance with ASTM A123. Galvanize bolts, nuts and washers and iron and steel hardware components in accordance with ASTM A153.
 - c. Safeguard products against steel embrittlement in conformance with ASTM A143.
 - d. Handle all articles to be galvanized in such a manner as to avoid any mechanical damage and to minimize distortion.
 - e. Coating Weight: conform with paragraph 5.1 of ASTM A123, Table 1 of A767, or Table 1 of ASTM A153, as appropriate.
 - f. Surface Finish: Continuous, adherent, as smooth and evenly distributed as possible and free from any defect detrimental to the stated end use of the coated article.
 - g. Adhesion: Withstand normal handling consistent with the nature and thickness of the coating and normal use of the article.
4. Testing:
 - a. Inspection and testing of hot dip galvanized coatings shall include visual examination and tests in accordance with ASTM A123, A767 or A153 as applicable to determine the thickness of the zinc coating on the metal surface.
 - b. Furnish Notarized Certificate of Compliance with ASTM Standards and Specifications herein listed. The Certificate must be signed by the galvanizer and contain a detailed description of the material processed. The Certificate shall include information as to the ASTM standard used for the coating.
5. Repair or Damaged Coating:
 - a. The maximum area to be repaired is defined in accordance with ASTM A123 Section 4.6 current edition.
 - 1) The maximum area to be repaired in the field shall be determined in advance by mutual agreement between parties.
 - b. Repair areas damaged by welding, flame cutting or during handling, transport or erection by one of the approved methods in accordance with ASTM A780 whenever damage exceeds 3/16" in width. Minimum thickness requirements for the repair are those described in ASTM A123 section 4.6 current edition.

O. System O – Wall Board, Water Resistant – Interior Wall Light Chemical Exposure

1. Examples of this classification include the following surfaces:

- a. Wall board where exposed to Water and/or light chemicals.
2. Surface Preparation:
 - a. Clean & Dry
 - b. Surfacer/Filler for joints and screw holes: Surfacing Epoxy Series 215 and Series 273 Part D fiberglass tape
 3. Coating System:
 - a. Primer: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
 - b. Finish: Hi-Build Epoxoline II L69 at 4.0 – 6.0 mils dft
- P. System P – Ferrous Metal – Immersion – Moderate Chemical Exposure including H₂S vapor exposure.
1. Examples of this classification include the following surfaces:
 - a. Primary Clarifier Mechanisms
 2. Surface Preparation: SSPC-SP10 Near-White Blast Cleaning with a minimum angular anchor profile of 2.0 mils.
 3. Coating System:
 - a. Primer: Tneme-Liner Series 61 at 10.0 – 12.0 mils dft
 - b. Finish: Tneme-Liner Series 61 at 10.0 – 12.0 mils dft
- Q. System Q – Concrete Floors in Moderate Chemical Exposure Installations.
1. Examples of this classification include the following surfaces:
 - TWAS Enclosure – Chemical Storage Area**
 2. Surface Preparation: Prepare in accordance with SSPC-SP13/NACE 6 and ICRI Technical Guidelines. Abrasive Blast, shot-blast or mechanically abrade concrete surfaces to provide a minimum ICRI-CSP 3 or greater surface profile.
 3. Coating System:
 - a. Prime Coat: Series 201 Epoxoprime at 200 – 260 square feet per gallon (6.0 – 8.0 mils).
 - b. Intermediate Coat: Series 282 Tnemec-Glaze at 160 - 200 square feet per gallon (8.0 to 10.0 mils). For texture - randomly broadcast 30/50 mesh dry wash silica into the wet Series 282.
 - c. Finish Coat: Series 282 Tnemec -Glaze at 160 - 200 square feet per gallon (8.0 to 10.0 mils).

PART 3 - EXECUTION

3.1 SHOP PAINTING

- A. Surface Preparation - All ferrous metal to be primed in the shop shall have all rust, dust and scale, as well as all other foreign substances, removed by sandblasting or pickling in accordance with SSPC-SP10. Cleaned metal shall be primed or pretreated immediately after cleaning to prevent new rusting. Under no circumstances will cleaned metal be allowed to sit overnight before priming, or pretreatment and priming. All nonferrous metals shall be solvent cleaned prior to the application of primer. In addition, galvanized surfaces which are to be topcoated shall first be degreased then primed. Refer to manufacturer's printed literature for the correct blast profile for the product used.
- B. Materials Preparation:
1. Mix and prepare painting materials in strict accordance with manufacturer's recommendations and directions, stirring materials before and during application to maintain a mixture of uniform density, free of film, dirt and other foreign materials.
 2. No thinners shall be used except those specifically mentioned and only in such quantity as directed by the manufacturer in his instructions. If thinning is used, sufficient additional coats shall be applied to assure the required dry film thickness is achieved. The manufacturer's recommended thinner or cleanup solvent shall be used for all clean-up. Application by brush, spray, airless spray or roller shall be as recommended by the manufacturer for optimum performance and appearance.
- C. Applications:
1. All painting shall be done by skilled and experienced craftsmen and shall be of highest quality workmanship. Coating systems shall be as specified herein.
 2. Apply paint in accordance with the manufacturer's directions. Use applicators and techniques best suited for the type of material being applied.
 3. All paint and coatings materials shall be stored under cover and at a temperature within 10°F of the anticipated application temperature and at least 5°F above the dew point.
 4. Apply additional coats when undercoats, stains or other conditions show through the final coat of paint, until the paint film is of uniform finish, color and appearance.
 5. Paint shall be applied in a neat manner with finished surfaces free of runs, sags, ridges, laps and brush marks. Each coat shall be applied in a manner that will produce an even film of uniform and proper thickness.
 6. Paint back sides of access panels and removable or hinged covers to match the exposed surfaces.
 7. Equipment manufacturer or supplier shall provide touch-up paint for items with shop applied finish coats.

8. 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.
- D. 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.

3.2 EXAMINATION

- A. Examine areas and conditions where painting work is to be performed. Notify Engineer in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.
- 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 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 2.3 Coating Systems.

3.3 SURFACE PREPARATION

- A. General:
 1. Perform all preparation and cleaning procedures as specified and in strict accordance with paint manufacturer's instructions for each particular substrate and atmospheric condition.
 2. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items not to be finish painted, or provide surface applied protection prior to surface preparation and painting operations. Following completion of painting of each space or area, reinstall removed items by workmen skilled in the trades involved or remove applied protection, if applicable.
 3. Clean sand, dirt, dust and all other foreign matter from surfaces to be painted before applying paint or surface treatments. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program cleaning and painting so that dust and other contaminants from cleaning process will not fall in wet, newly painted surfaces.
 4. Prepare surfaces which were not shop painted or were improperly shop painted or damaged, and all abraded or rusted surfaces, which are to be painted, as specified under 3.2 C. and as follows.
 5. Priming Blast Cleaned Metal: Prime blast cleaned metal within 24 hours or before any rust bloom occurs.

6. Primed surfaces, exposed to sunlight for 60 days or more, must be scarified by lightly sanding or whip blasting to assure proper adhesion of final coat(s). The surface to be painted shall be solvent cleaned by SSPC SP1 to remove any grease, dirt, etc. If structures which require painting have been near the coast and exposed to salt air, a salt remover such as Chlor-rid may be required before cleaning.
7. If there is a time period in excess of five (5) months from application of a shop or field primer coat to proposed date to apply the first field finished coat, first field finished coat will not be applied. Instead, blast clean primer completely off to obtain the SSPC-SP surface specified for particular application in Painting Systems. Then, reapply primer and finish paint as specified. Cost of removing primer by blast cleaning and reapplying primer will be at no expense to Owner.
8. Terminate shop prime coats on steel six inches from edges that are to be field welded.

B. Ferrous Metal Surfaces:

1. Shop or Field Primed for Submerged or Intermittently Submerged in Liquid Service:
 - a. Grind smooth to a rounded contour sharp edges and welds, and remove weld splatter.
 - b. Except for insides of pipes, blast clean in accordance with SSPCSP10 Near-White Finish and to obtain a minimum blast profile of 1.5 mils.
 - c. After blast cleaning, remove dust and spent sand from surface by brushing or vacuum cleaning.
 - d. Apply prime coat before rust bloom forms or within 24-hours, whichever is earlier.
 - e. Do not allow blast cleaned or bare surfaces to stand overnight before coating.
2. Not Shop Primed and Non-Submerged:
 - a. Grind smooth to a rounded contour sharp edges and welds, and remove weld splatter.
 - b. Solvent clean in accordance with SSPC-SP 1 so that all surfaces are free of oil and contaminants with a non-petroleum based solvent recommended by the coating manufacturer.
 - c. Pressure wash all areas to be painted with a minimum 3000 psi pressure washer using potable water. Use a cleaner such as Chlor*Rid or equivalent to remove all dirt, salt, and contamination before proceeding and prevent any salts from being driven into the metal by blasting. Exercise caution around any operating electrical equipment.
 - d. Sweep blast clean in accordance with SSPC- SP 7. On areas that have been removed to bare metal, taper back edges to tightly adhered coating. Protect all rotating equipment and concrete from the abrasive blasting. On interior metal surfaces where abrasive blasting may damage electrical components, rotating equipment, thin gauge conduit, etc., Power Tool Cleaning per SSPC-SP3 or Hand Tool Cleaning per SSPC-SP2 may be used if requested and approved by the Engineer prior to beginning.
 - e. After blast or other cleaning, remove dust and spent sand from surface by brushing or vacuum cleaning.
 - f. Apply prime coat before surface starts to rust or within 24-hours, whichever is earlier.

- g. Do not allow blast cleaned or bare surfaces to stand overnight before coating.
3. Not Shop Primed and Non-Submerged, Reservoir & Potable Water Storage Tanks:
- a. Grind smooth to a rounded contour sharp edges and welds, and remove weld splatter.
 - b. Solvent clean in accordance with SSPC-SP 1 so that all surfaces are free of oil and contaminants with a non-petroleum based solvent recommended by the coating manufacturer.
 - c. Pressure wash all areas to be painted with a minimum 3000 psi pressure washer using potable water. Use a cleaner such as Chlor*Rid or equivalent to remove all dirt, salt, and contamination before proceeding and prevent any salts from being driven into the metal by blasting.
 - d. Commercial blast clean in accordance with SSPC- SP 6 to obtain a minimum 1.5 mils blast profile. Protect all rotating equipment and concrete from the abrasive blasting.
 - e. After blast cleaning, remove dust and spent sand from surface by brushing or vacuum cleaning.
 - f. Apply prime coat before surface starts to rust or within 24-hours, whichever is earlier.
 - g. Do not allow blast cleaned or bare surfaces to stand overnight before coating.
4. Shop Primed:
- a. Immediately before paint application, clean sand, dust, mud, dirt and other foreign matter from shop coat.
 - b. Touch-up damaged or destroyed shop paint.
 - c. Surface preparation of surfaces to be touched-up must be as effective as those specified for shop painting. A minimum SSPC SP3 should be used. Immersion service will require abrasive blasting.
5. Ferrous metal surfaces previously exposed to sulfides shall be sandblasted, washed, and sandblasted again in accordance with the recommended surface preparation for the particular service in question.
6. Where blast cleaning is done in the field, only "virgin" sand, grit, or abrasive will be used.
7. Inaccessible areas, such as, behind tank rafters or skip-welded lap joints, or in between back-to-back angle iron bracing, shall be coated before assembly to prevent corrosive action from taking place in these in accessible areas. All surface voids shall be sealed-welded and back-toback bracing and tank rafters either coated before assembly or eliminated from the design and construction. Sharp corners and edges shall be ground to a smooth contour and welds prepared as described above.

C. Concrete Surfaces:

- 1. All concrete surfaces to be coated shall be clean and dry. "Dry" is defined for new concrete as free of moisture and fully cured which is a minimum of 28 days at 75°F and 50 percent Relative Humidity or some equivalent cure time at other conditions (7 days minimum for stucco). Moisture content of concrete shall be checked by taping a one-foot

square piece of 20 mil thick minimum plastic film on the surface (“plastic film tapedown test” ASTM D 4263). Test film should be placed at various locations that are likely to be slow drying out, such as below grade, low spots in floors, inside corners and lower wall areas. The film should be carefully sealed with tape to prevent the escape of any moisture or vapor that would be trapped behind the film. The film should be left in place over night or longer to allow sufficient time for moisture migration. After 48 hours remove and examine the backside for moisture condensation and inspect the concrete surface for darkened areas. The source of the moisture, if present, shall be located, and the cause corrected prior to coating. All oil, grease, dirt, etc., shall be removed either by steam cleaning with detergent or by scrubbing with a hot trisodium phosphate solution consisting of 2 pounds of trisodium phosphate to each gallon of hot water (160° F). Repeat the cleaning operation until the contamination is removed and flush the area with clean water to remove residual cleaning solution. Allow to dry thoroughly before coating.

2. Old paint and unremoved tar stains shall be solvent cleaned with naphtha, trichloroethylene, or perchloroethylene. Proper safety precautions shall be observed if this step is necessary. The surface shall be flushed with fresh water and dried.
3. Do not use form oils incompatible with coating, concrete curing agents or concrete hardeners on concrete surfaces to be coated.
4. Concrete and/or cinder block walls to receive a coating shall be air-blasted with 100 psi clean, dry, oil-free air to remove dust, etc., and wire brushed to remove all loose and/or weak mortar. See requirements for sumps, tanks and other water-bearing structures below. These surfaces may also be pressure washed with a minimum 3,000 psi.
5. Concrete floors shall be thoroughly swept clean and prepared in accordance with an ICRI CSP profile dependent on the material used. Contact the paint manufacturer for specific surface preparation requirements.
6. The floors or concrete sumps, tanks or other water-bearing structures should be prepared in accordance with the appropriate ICRI CSP standard for the system used (typically ICRI CSP3 or CSP5). Patch voids and cracks that will cause discontinuities in the coating or unsightly appearance using a patching compound compatible with the coating system.

D. Masonry and Precast Concrete:

1. Clean out cracks, loose mortar, chips, indentations and open pores.
2. Patch with mortar all depressions.
3. Perform work only on cured, dry and dust free masonry surfaces.
4. Apply surfacer recommended by paint manufacturer in accordance with manufacturer's procedures.

E. Wood Surfaces: Wood should be clean and dry. Remove surface deposits of sap or pitch by scraping and wiping clean with rags dampened with mineral spirits or VM & P Naphtha. 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.

F. Stainless Steel:

1. Stainless steel will only be coated when so specified.
2. Stainless steel requires only solvent cleaning prior to coating using any one of the methods in SSPC-SP1. Only solvents and cleaning solutions containing less than 200 ppm of halogens should be used to prevent stress corrosion cracking.
3. Stainless steel may be shot-blasted to provide a surface profile to increase the mechanical bond of the coating system. The height of the profile and the texture required should be defined for the operator and as a standard for the acceptance of the work. Pictorial standards for the surface cleanliness of carbon steel are not applicable to stainless steel, since there are no corrosion products or mill scale to remove from the surface.
4. Abrasive blast cleaning procedures outlined by Steel Structures Painting Council for carbon steel may also be used for stainless steel. Only very hard silica sand or other abrasive media should be used for a fast cutting action and to obtain a sharp angular profile.

G. 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 or 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.

H. Galvanized Steel, and Non-Ferrous Metal:

1. Galvanized steel and aluminum will only be coated when so specified.
2. Surfaces shall be clean and dry. Remove dust and dirt by blowing off the surface with high pressure air or wiping clean with dry rags. Oil, grease and protective mill coatings should be removed by solvent cleaning in accordance with SSPC-SP1.
3. All galvanized surfaces for non-immersion service should be cleaned with a minimum SSPC SP3 or brush blasted to remove any passivation layer and to provide a surface profile.
4. Other surface preparation as outlined in the coating manufacturer's latest written Application Instructions shall be observed more demanding exposures.

I. Previously-Painted Surfaces (except ferrous metal, non-immersion):

1. Careful examination of the old coating is necessary in order to determine the condition of the coating prior to recommending the degree of surface preparation that will be needed. The old coating should be shaved with a knife to ascertain its present adhesion to the substrate, as well as the flexibility of the film. If the old coating has a tendency to powder or shatter easily under the knife, or disbonds freely from the substrate or underfilms, it would indicate total removal is necessary.
 - a. When up to 10 percent of the total area has failed, spot blasting back to at least one-inch into sound film, feathering of edges and spot priming is required.
 - b. When the coating system has deteriorated to approximately 25 percent of the total area, or if the coating is brittle, eroded or underfilm rusting is present, completely remove original coating system by sandblasting as specified.
2. Tank linings, immersion-service coatings, and some other types of high performance coatings require total removal before recoating. Consult manufacturer's recommendations for which of the other types of high performance coatings require total removal.
3. In instances where the film has been eroded due to weathering or worn thin due to abrasion or impingement with no rusting, the surface contaminants may be removed through water blasting (approximately 3,000 psi or more, over 4 gallons per minute) with emulsifying agents or cleaners, rinsed and dried. Roughening of the surface shall be used to improve the adhesion of subsequent coats. Recoat with the recommended finish coat(s).

J. PVC or Other Plastic Piping or Ductwork:

1. Remove any grease or oily residue on PVC.
2. Lightly sand off sheen and clean. Abrade surface.
3. If recommended by manufacturer, lightly abrade surface with medium grade sandpaper. Remove dust by wiping with clean rags.
4. Remove dust and sand by wiping with a dry cloth. Apply coating before any contamination.

K. Shop Bituminous Coated Pipe:

1. Hand tool clean in accordance with SSPC-SP 2.
2. Wipe or brush clean.
3. Recoat with compatible bituminous coating.

3.4 MATERIALS PREPARATION

A. General:

1. Mix and prepare painting materials in strict accordance with manufacturer's directions.

2. Do not mix coating materials produced by different manufacturers.
3. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in a clean condition, free of foreign materials and residue.
4. Stir all materials before application to produce a mixture of uniform density, and as required during application of materials. Do not stir any film which may form on surface into material. Remove film and, if necessary, strain material before using.
5. If material has thickened or must be diluted for application, buildup coating to same film thickness achieved with undiluted material. Do not use thinner to extend coverage of paint unless recommended by the manufacturer and listed on their product literature.

B. Tinting:

1. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat. Provide code number that identifies material tinted by manufacturer.

3.5 APPLICATION

A. General:

1. Strictly follow paint manufacturer's label instructions for proper application, spreading rate and drying time.
2. Apply paint by brush, roller, air spray, or airless spray in accordance with manufacturer's directions, and recommendations of Paint Application Specifications No.1 in SSPC Vol. 2, where applicable. Use brushes best suited for type of material being applied. Use rollers of carpet, velvet back, or high pile sheep's wool as recommended by paint manufacturer for material and texture required. Do not use rollers having nap exceeding 3/8-inch.
 - a. Apply by brush to newly welded seams.
 - b. Apply prime coats by roller, brush, or spray.
3. Apply paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 and 95 degrees F, and will remain in this range during curing, unless otherwise permitted by paint manufacturer's printed instructions.
4. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or to damp or wet surfaces.
5. Painting may be continued during inclement weather only if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.
6. Provide adequate illumination and ventilation in areas where painting operations are in progress.

7. Maintain number of coats and minimum paint film thickness per coat required regardless of application method. Do not apply succeeding coats until previous coat has completely dried or the minimum time recommended by manufacturer has elapsed, whichever is longer.
 8. Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint, and until paint film is of uniform finish, color and appearance. This requirement is of particular importance regarding intense primary accent colors. Ensure surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a film thickness equivalent to that of flat surfaces.
 9. Surfaces not exposed to view do not require color coding and in some cases do not require painting.
 10. Paint interior surfaces of ducts (in accordance with materials), where visible through registers or grilles, with a flat, non-specular black paint as specified, before final installation of equipment.
 11. Paint backs of access panels, and removable or hinged covers to match exposed surfaces.
 12. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces, unless otherwise specified.
 13. Do not apply paint over sealants and caulking compounds until integral solvents have been released from compound. Conform to sealant and caulking manufacturer's recommendations.
 14. Paint existing structural steel to match new structural steel.
 15. Spray painting of sound-absorbing concrete masonry units containing sound insulation material is prohibited. This requirement prevents insulation material from being sprayed, resulting in a consequent loss of sound attenuation effectiveness. Apply paint on sound-absorbing masonry by rolling or brushing.
 16. Sprayed Finishes: Spray paint finish doors, frames and windows, where required. Brush or roller finishes will not be acceptable.
 17. Install piping markers and safety signs only after painting and finish work is completed.
- B. Minimum Coating Thickness: Apply each material at not less than the manufacturer's recommended spreading rate, and provide total dry film thickness as specified. In no case allow area coverage per gallon to exceed manufacturer's recommendations. Apply extra coat at no additional expense to obtain specified total dry film thickness.
- C. Scheduling Painting:
1. Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

- a. Apply primers before rust bloom forms but in no case allow cleaned steel to be exposed for more than 24-hours.
- 2. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of undercoat. In no case apply an additional coat until manufacturer's minimum recommended drying time between coats has elapsed.
- D. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects caused by insufficient sealing.
- E. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling such as laps, irregularities in texture, skid marks, or other surface imperfections.
- F. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.
- G. Brush Application:
 - 1. Brush-out and work all blush coats onto surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are not acceptable. Neatly draw all glass and color break lines.
 - 2. Brush apply all primer or first coats, unless otherwise permitted to use mechanical applicators.
- H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements as required by the Engineer.
- I. Placing Into Service: Do not place painted items into service until paints and coatings are fully cured (dry-hard).
- J. Safety Signs: Apply safety signs at locations directed by Engineer.

3.6 RE-PAINT SURFACE PREPARATION

- A. Assume complete responsibility for quality of repaint work insofar as proper surface preparation will affect finished appearance. Quality of finishes is subject to Engineer's approval or rejection. Recoat work as a result of rejection will be at no expense to Owner.
- B. Prepare previously painted surface where rust, powdering, scaling, peeling or flaking is present by wire brushing, scraping, sanding and blast cleaning to solid material. Sand solid edges smooth. Taper back edges to tightly adhered coating.
- C. Prepare hard, glossy, repaint surfaces for paint adhesion by sandpapering, followed by surface washing and rinsing. When a de-glosser is used, washing and rinsing may be eliminated.

- D. To avoid rust showing from nails' heads in repainted wood surfaces, countersink nails and fill holes, together with all other crevices, with wood filler similar to DAP 33 after priming coat has dried. Lightly sand wood filler to a smooth surface. Coat knots and sappy spots with shellac before painting.
- E. Just prior to application of paint or coatings, re-paint surfaces must be dry, clean and free of loose dirt, dust and grit.
- F. Patch test unknown old coatings for compatibility.

3.7 FIELD QUALITY CONTROL

- A. Engineer reserves right to invoke following material testing procedure at any time, and any number of times during the period of field painting.
 - 1. Engage the service of an independent testing laboratory to sample any paint being used. Samples of materials delivered to Project site will be taken, identified and sealed, and certified in presence of Contractor.
 - 2. Have independent testing laboratory perform appropriate tests for any or all of following characteristics: abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali resistance, quantitative materials analysis, and compatibility of coatings.
 - 3. If test results show that material being used does not comply with specified requirements, a directive may be made, at no expense to Owner, to stop painting work and remove non-complying paint; pay for testing; repaint surfaces coated with rejected paint; remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two (2) coatings are non-compatible.
- B. Testing Equipment:
 - 1. Provide calibrated magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by ElektroPhysik U.S.A., Arlington Heights, IL, MikroTest Digital or other Engineer-approved manufacturer.
 - 2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
 - 3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.
- C. Testing:
 - 1. Thickness and Continuity Testing:

- a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before coat has dried.
 - b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.
 - c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE RP0188.
 - d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.
- D. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.
- E. Unsatisfactory Application:
1. If an item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
 2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
 3. Repair defects in accordance with written recommendations of coating manufacturer.
- F. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repair in accordance with recommendations of paint manufacturer.
 2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
 3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.8 PROTECTION

- A. Protect work of other trades against damage caused by painting and finishing work. Correct damages by cleaning, removing paint splatter, repairing or replacing, and repainting, as acceptable to Engineer.
- B. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided after completion of painting operations.
- C. Protect painted surfaces from damage. Touch up and restore damaged or defaced painted surfaces as determined by Engineer.

3.9 CLEANING

- A. The Contractor shall perform the work under this Section while keeping the premises free from accumulation of dust, debris and rubbish and shall remove all scaffolding, paint cloths, paint, and brushes from the building when completed.
- B. Cleaning: All paint brushed, splattered, spilled or splashed on any surface not specified to be painted shall be removed.
- C. The Contractor shall insure that all glass throughout that portion of the facility in which he worked is cleaned of dirt and paint before he leaves the job site. Further, the Contractor shall insure that all glass in this area is thoroughly washed and polished.
- D. Upon completion of the project, the job site shall be left neat and clean.

END OF SECTION 098000

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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 104416

SECTION 108113 – BIRD CONTROL DEVICES

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Bird deterrent or stainless steel bird barrier spike Models: Physical surface barriers designed to prevent all types of pest birds and climbing animals from landing, roosting, nesting or climbing on architectural surfaces, in all infestation levels.
- B. Bird Spike Mounting Hardware: Stainless steel mounting clips combined with mechanical fasteners to hold the Bird Spikes to all types of architectural surfaces. All mounting hardware shall be made of stainless steel or non-corrosive materials.
- C. Surface Cleaning System: Surface disinfectants, deodorizers and personal protection equipment (PPE) that help keep installers safe when neutralizing the potentially hazardous bird or animal wastes that may be present. The cleaning system then sanitizes and deodorizes the surface in preparation of the Bird Spike installation.

1.2 QUALITY ASSURANCE

- A. Installer to obtain, review and understand manufacturers planning guides, estimating worksheets and installation instructions.
- B. Installer must be completely familiar with the proper installation procedures for the All Stainless Steel Bird Spike models specified for installation Product Data: For each type of process and factory-fabricated product.
- C. Installer must be completely familiar with the specified mounting hardware and mounting hardware installation procedures.
- D. Installer must obtain and record accurate and complete dimensions for each surface specified for Bird Spike installation.

1.3 SUBMITTALS

- A. Manufacturers literature including: Planning Guide, completed Estimate Worksheet(s) and installation instructions for the specified Bird Spike Model and specified mounting hardware.
- B. B.Sample of specified Bird Spike Model - not less than 2” (5.1cm) in length.
- C. Sample of specified Bird Spike Mounting Hardware.

1.4 STORAGE & HANDLING

- A. Provide storage and/or protection to keep Bird Barrier Spike shipping boxes dry, clean and undamaged. Do not stack or place other packaging or objects on the Bird Barrier Spike shipping boxes.
- B. Keep All Stainless Steel Bird Barrier Spikes and Mounting Hardware in original packaging until needed for installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- A. Nixalite of America Inc 1025 16th Avenue, PO Box 727, Dept. NI, East Moline, Illinois 61244; U.S.A.
- B. Or equal.

2.2 BIRD BARRIER STRIPS

- A. Wires: Stainless steel, 0.041" (1 mm) diameter, full-hard spring temper.
- B. Base Strip: Stainless steel, 0.25" wide x 0.02" thick (6.3 mm x 0.5 mm), full anneal for flexibility, easy strip cutting and surface shape memory.
- C. Spike Strip Lengths: 24" strip lengths.
- D. Premium Nixalite Model S (or equal): Full row spike, 4" high (10.2 cm), 4" wide (10.2 cm) NO LESS THAN 120 wire points per foot. Full 180-degree wire coverage. For all bird species on all types of surfaces. Use in conjunction with Premium Nixalite Model W for climbing animal barrier and mud-nest building bird control applications.
- E. Premium Nixalite Model W (or equal): Wall mount spike. 5-1/2" high (14.0 cm), 3" wide (7.6 cm), NO LESS THAN 120 wires per foot, 180-degree wire coverage. Designed for vertical surfaces only. Use above surfaces less than 2" in depth (5.1 cm) or over other Nixalite Models when specified. Use in conjunction with Premium Nixalite Model S for climbing animal barrier and mud-nest building bird control applications.
- F. Finish: Natural stainless steel finish or manufacturers ColorCoat finish.

2.3 BIRD SPIKE MOUNTING HARDWARE

- A. Use the Bird Spike Mounting Hardware that best suits the installation surface. All hardware is made of either stainless steel .

<u>Installation Surface</u>	<u>Nixalite Bird Spike Mounting Hardware</u>
Masonry, stone, concrete;	Mounting clip, sheet metal screw, masonry anchor

Wood, plywood, shingles;	Mounting clip, sheet metal screw, washer
Sheet metal, plastic, PVC;	Mounting clip, sheet metal screw, washer
Steel, cast iron, brass, bronze;	Mounting clip, drive screw, washer
Pipes, cables, conduit, grates;	Wire tie, wire tying tool, adhesive

- B. Apply adhesive or sealant in all holes that penetrate the installation surface. After mounting hardware is installed, apply additional adhesive or sealant over the heads of the sheet metal screws and/or the drive screws. Do not get adhesive or sealant in the hook end of the mounting clips.
- C. Optional Fastening:
 - 1. Glue Clips & Adhesive:
If surface conditions do not allow for the use of the supplied Bird Spike Mounting Hardware, use the Glue Clip and Adhesive installation method. Follow the Glue Clip installation instructions available from the manufacturer.

2.4 SURFACE CLEANING SYSTEM

- A. Steri-Fab (or equal): Surface disinfectant and bactericide designed to neutralize bird waste, making it safe for removal. Steri-Fab quickly kills disease causing bacteria, parasites, fungi, insects, etc. This is a non-residual product. It becomes completely inert after it dries. Do not use with Microcide-SQ on the same surface at the same time Retain.
- B. Microcide-SQ (or equal): A broad spectrum disinfectant, cleaner and deodorizer used to sanitize hard surfaces as well as fabrics and clothing. Use to kill a wide spectrum of organisms and disease causing bacteria. Do not use with Steri-Fab on the same surface at the same time.
- C. Microsan (or equal): Anti-microbial personal protection products to help prevent disease transmittal before, during and after working on and around surfaces contaminated with bird and animal wastes. Use to compliment personal protection equipment standards (PPE).

PART 3 - EXECUTION

3.1 INSPECTION

- A. Visually inspect all installation surfaces. Make sure all surfaces are clean, dry and free from debris or other conditions that could impede the workflow of this section. All surfaces must be sanitized and deodorized before installation of Bird Spikes.
- B. Notify architect of detrimental conditions. Do not proceed until these conditions have been corrected.

3.2 PREPARATION

- A. Field Measurements: Verify the dimensions for each surface specified for Bird Spike installation. Use manufacturers Planning Guides and Estimate Worksheets to verify that sufficient quantities of bird spike strips will be installed on EACH surface specified for bird control.
- B. Make sure all installation surface finishing requirements have been accomplished before installing Bird Spikes. They are to be the last items installed on each specified surface. DO NOT apply any surface coating or treatment (paint, sealer, etc.) over the installed Bird Spikes or the mounting hardware.
- C. Remove or relocate all plants, foliage or foreign objects that overhang the installation surfaces. Note all conditions that could adversely affect the installation and performance of the Bird Spike installation

3.3 SURFACE CLEANING

- A. All surfaces to be clean, dry and free of obstructions before the Bird Spikes are installed.
- B. If Bird Waste Is Present:

Treat, neutralize and safely remove all bird waste from installation surfaces. Installer must follow all municipal, state and federal regulations regarding the proper removal and disposal of bird droppings and waste materials such as nests and dead birds.
- C. Use surface cleaning products to neutralize any bird droppings, nests and related waste materials that may be present. Allow all surfaces to air dry completely, and then reapply to sanitize and deodorize the surface before proceeding. Strictly follow treatment instructions provided with surface cleaning products.
- D. Use anti-microbial and anti-bacterial personal protection products to help prevent disease transmittal when working around surfaces contaminated with bird droppings.

3.4 INSTALLATION

- A. Make sure the installation surfaces are clean, dry and free of any debris or obstructions.
- B. Install specified Bird Spike Models in strict accordance with manufacturer's spike strip spacing and installation guidelines. Protect all surfaces where pest birds can land, roost and nest.
- C. Install bird spike strips so they will protect the entire surface, not just the outside edges. No gaps are allowed in the bird spike strip coverage. Cut the bird spike strips where necessary to fit the surface properly.
- D. Wires of Bird Spike Models must extend over outside edges of each surface by at least 1/4" (0.6cm). The bird spike base strip must extend over the ends of each surface by at least 1/2" (1.2cm).

- E. Fasten Bird Spike Models to the surface with the mounting hardware recommended by the manufacturer. Follow the hardware spacing guidelines and installation procedures supplied by manufacturer.

3.5 ADJUSTMENTS / CLEANING

- A. Remove debris and waste materials from project site. Inspect finished installation. Make any adjustments needed to conform to spacing and installation guidelines.

END OF SECTION 108113

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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 Section 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 vicinity of San Rafael, California. Design weather conditions are: summer 98° F (max), and winter 30°F (min). Altitude readings, unless otherwise noted, are approximately 10 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 requirements 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 additional requirements 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

LGVSD

TWAS ENCLOSURE & SLUDGE STORAGE

GENERAL MECHANICAL REQUIREMENTS

220010- 8

- 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-180. 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, and 23, 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

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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 California.
 - 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 250°F. 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 230°F (110°C), 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.
- 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 170°F, 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 0oF (-18oC) where possible, with minimum pipe preheat to 50oF.
4. Bevel pipe ends at a 37.5o 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 221066, "Pipeline Testing".
- B. Disinfect water mains and water service piping in accordance with AWWA C601.

END OF SECTION 220050

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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, $\frac{3}{4}$ and $\frac{1}{2}$ 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 2.06C.
- 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 megohmmeter 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 220513

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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 220519 – METERS AND GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Special Conditions and Technical Specification sections, apply to work of this section.
- B. Section 409119 Physical Properties Process Measurement Devices

1.2 DESCRIPTION OF WORK:

- A. Extent of meters and gauges required by this section is indicated on drawings and/or specified in other Division-22 and 40 sections.
- B. Types of gauges specified in this section include the following:
 - 1. Pressure Gauge and Fittings.
 - a. Pressure Gauge Cocks.
 - b. Pressure Gauge Connector Plugs.
 - c. Pressure Sensors.
 - 2. Installation of magnetic flow meters, sensor and water flow meters, sensors, wells, etc., furnished by Division 40.

1.3 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of meters and gauges, of types and sizes required, whose products have been in satisfactory use in similar service.

1.4 CODES AND STANDARDS:

- A. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.
- B. ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.
- C. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

1.5 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES:

- A. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. See section 409119 for additional requirements.

2.2 PRESSURE GAUGE COCKS:

- A. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock shall be stainless steel bar stock needle valve Trerice No. 735 or a full ported stainless steel ball valve.
- B. Snubber: 1/4" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.
- C. Manufacturer: Same as for pressure gauges.

2.3 PRESSURE GAUGE CONNECTOR PLUGS:

- A. General: Provide pressure gauge connector plugs pressure rated for 500 psi and 200 degrees F (93 degrees C). Construct of stainless steel, equip with 1/2" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.
- B. Manufacturer: Subject to compliance with requirements, provide pressure gauge connector plugs of one of the following:
 - 1. Peterson Equipment Co.
 - 2. Sisco.

2.4 PRESSURE SLEEVE SENSORS:

- A. Pressure sensors shall be sensed by a flexible sleeve contained in a flanged stainless steel spool or wafer body, and transmitted to the gauge through a captive fluid. The sleeve shall be of Buna N and fabricated so as to isolate the body from the process liquid.
- B. Gauges shall be calibrated to read in applicable units, with an accuracy of ± 1 percent, to 150 percent of the working pressure of the system to which they are connected.
- C. Series 40
Manufacturer, or Equal: Red Valve Company, Inc.;

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which meters and gauges are to be installed.

3.2 INSTALLATION OF PRESSURE GAUGES:

- A. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
- B. Locations: As shown on the drawings.
- C. Pressure Gauge Cocks: Install in piping tee with snubber.
- D. Pressure Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.3 ADJUSTING AND CLEANING:

- A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION 220519

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SECTION 220523 – VALVES

PART 1 - GENERAL

1.1 SCOPE:

- A. The Contractor shall provide valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.
- C. Unit Responsibility: A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.
- D. Single Manufacturer: Where two or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 RELATED SECTIONS

- A. Section 220525 – Valve and Gate Actuators

1.3 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.

1.4 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 - PRODUCTS

2.1 PRODUCTS

- A. General: Valves shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Gate valves 18-inches and larger or where chain wheel is required, shall be furnished with spur gear and hand wheel. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.
- B. Valve Actuators: Unless otherwise indicated, valve actuators shall be in accordance with Section 220525 - Valve and Gate Actuators.
- C. Protective Coating: The exterior surfaces of all valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated in accordance with Section 098000 – Protective Coatings. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.
- D. Valve Labeling: Except when such requirement is waived by the construction manager in writing, a label shall be provided on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch stainless steel, minimum 2-inches by 4-inches in size, as indicated in Section 220553- Identification for Piping and Equipment, and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the construction manager.
- E. Valve Testing: As a minimum, unless otherwise indicated or recommended by the reference Standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:
 1. Hydrostatic Testing: Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valves rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.
 2. Seat Testing: Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage. Test duration

shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.

3. Performance Testing: Valves shall be shop operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.
- F. Certification: Prior to shipment, the Contractor shall submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.
- G. Valve Marking: Valve bodies shall be permanently marked in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

- A. General: Materials shall be suitable for the intended application. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:
1. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 2. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 3. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.
 4. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications.
 5. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.
 6. PVC: Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.
 7. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.
 8. NSF Standard 14: Materials shall be listed for use in contact with potable water.

2.3 VALVE CONSTRUCTION

- A. Bodies: Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated, and be rated for the maximum temperature and pressure to which the valve will be subjected.
- B. Valve End Connections: Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.
- C. Bonnets: Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.
- D. Stems: Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal. Bronze valve stems shall conform to ASTM B 584, except that zinc content shall not exceed 16 percent.
- E. Stem Guides: Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 304 stainless steel.
- F. Internal Parts: Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.
- G. Nuts and Bolts: Nuts and bolts on valve flanges and supports shall be Stainless Steel in accordance with Section 055000 – Metal Fabrications.

2.4 VALVE ACCESSORIES

- H. Valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

- I. The Contractor shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the Owner, after expiration of the correction of defects period.

2.6 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. Or equal.

2.7 STAINLESS STEEL PLUG VALVES

- A. All plug valves that are indicated as stainless steel in the valve schedule shall have a body constructed of 316 stainless steel, ASTM A2216 Grade CF-8M.
- B. The bearings, bonnet and bonnet screws shall be 316 stainless steel. The plug shall be of the same material as the body.
- C. Valves shall DeZurik/APCO PEC Eccentric plug valves or equal and shall be made in the USA

2.8 AIR/VACUUM RELEASE VALVES

- A. Air/Vacuum relief valves (single body, double orifice) are used to allow large volumes of air to escape or enter thru the larger diameter air / vacuum orifice when filling or draining a pipeline. Series and model to accommodate clean water or waste water applications as indicated in the schedule.
- B. Service shall be for air relief only, vacuum break only, or combination air relief/vacuum break as indicated and required in the schedule. Connection shall be as indicated in the design drawing and schedule.
- C. Valves shall be manufactured and tested in accordance with AWWA Standard C512.
- D. The valve body shall be threaded with NPT inlets and outlets. The body inlet connection shall be hexagonal for a wrench connection. The main valve body shall be constructed of stainless steel.

- E. The valve shall have two additional NPT connections for the additions of gauges, testing, and draining.
- F. The Nozzle, Seat, Ring Seats shall be EPDM Rubber.
- G. All connection Screws, Nuts, and Bolts shall be Stainless Steel AISI 304L.
- H. Float shall be Stainless Steel ASTM A240 T304.
- I. Float Stem shall be Stainless Steel ASTM A581 T303
- J. 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.
- K. Available manufacturers:
 - 1. International Valve Vent-Tech
 - 2. Or Equal
- B. Valves shall be made in the USA.

2.9 HIGH PERFORMANCE BUTTERFLY VALVES

- A. Body: The valve body shall be one-piece wafer, lug or double flanged design appropriate for bi-directional service. Body construction material shall be as noted in the valve schedule.
 - 1. Provided with top and bottom stem bearings consisting of a 316 stainless steel shell with a TFE/glass fabric liner bearing surface.
 - 2. Equipped with an externally adjustable stem packing system that allows packing adjustment without removing the actuator.
 - 3. Internal over-travel stop shall be provided to prevent over-travel of the disc and minimize possible seat damage.
- B. Stainless Steel Disc: The valve disc edge and hub shall be spherically machined and hand polished for minimum torque and maximum sealing capability.
- C. Seat: The design shall consist of a resilient energizer totally encapsulated by the seat. The seat retainer shall be fully faces and firmly attached by bolts located outside the sealing area. The seat assembly shall be locked in the body recess by the full faced retainer. The seat shall be self-adjusting for wear and temperature changes. The seat material shall be EPDM. For process air applications, provide seat material capable of handling temperature of up to 250 degrees F.
- D. Stem: The valve stem shall be one-piece design provided with blow-out proof stem retention system.
- E. Available Manufacturers;
 - 1. Bray/McCannalok HP Series (Bray Series 40/41),
 - 2. Dezurik
 - 3. Or equal

2.10 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 70°F.
- 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. No equal.

2.11 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. No 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"

2.12 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 stem design
 - 10. Nylon lever grip
 - 11. 150 psi rated
- B. Available Manufacturers: Shall be made in the USA and subject to compliance with requirements, manufacturers offering ball valves which may be incorporated in the work are:

1. Apollo Valves
2. Or equal

2.13 STAINLESS STEEL GLOBE VALVES

- C. Features:
3. 316 SS Construction
 4. 316 SS Hub
 5. PTFE stem
 6. Externally adjustable PTFE packing
 7. NPT
 8. SS Gland Nut
 9. Integral metal to metal seat design
 10. 10,000 psi rated
- D. Available Manufacturers: Shall be made in the USA and subject to compliance with requirements, manufacturers offering ball valves which may be incorporated in the work are:
11. Apollo Valves
 12. Or equal

2.14 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 Griffco Valve – Series M or G, no equal.

2.15 STAINLESS STEEL MUD VALVES

- A. Mud valves shall be made in the USAS, stainless steel with resilient seats Trumbull series 376, Troy Valve (of Penn-Troy) or equal and 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 3/4". 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 or Troy Valve (of Penn-Troy).

2.16 SUCTION LINE FOOT VALVES

- A. The foot 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. Shall be made in the USA.
- B. The valve seat and plug shall be ASTM A351 Grade CF8M stainless steel. The basket screen shall be type 304 stainless steel.
- C. Foot 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.

2.17 GLOBE STYLE CHECK VALVES

- A. Check valve shall be of the silent operating type and the same size as the entering pipe.
- B. Globe style thru 24 inches shall be rated for 250PSI service, have a Ductile Iron body (ASTM A-536 65-45-12), 125# ANSI Flat Face Flanges, ASTM A313 Type 304 Stainless Steel helical or conical spring, a Stainless Steel (ASTM type 304) seat and dual guided disc (top and bottom), 304 Stainless Steel guide bushing and type 304 Stainless Steel guide pins.
- C. Check valve to have a minimum open area in the body of 110% of the area of the entering or corresponding pipe.
- D. Valve is to operate silently in either vertical or horizontal positions, flow up or down.
- E. Globe style check valve shall be Val-Matic 1400A/1800 Silent Check Valve or Apco Globe Style Series 600.

2.18 SWING CHECK VALVES

- A. The valves shall be designed, manufactured, tested and certified to ANSI/AWWA standards (C508). The valves shall be provided with flanges in accordance with ANSI B16.1 Class 125 (or above as required for each installation).
- B. The rubber flapper swing check valve shall be constructed of ASTM A536 Grade 65-45-12 ductile iron for sizes less than 30-inch diameter and cast iron body and cover in accordance with ASTM A126 Grade B for sizes 30-inches and larger. 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.
- C. 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.
- D. Buna-N flapper which creates an elastic spring effect to assist the flapper to close against a slight head to prevent or minimize slamming.

- E. 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.
- F. When necessary to prime or backflush a clogged pump, an external backflow device can be furnished—sizes 3” and larger.
- G. For the three swing check valves (36-V-1102, 36-V-1202, and 36-V1302) headloss through the valve is a critical aspect of the valve. The design basis valve lists ~6-inches of headloss through the valve at peak flow (6.4 MGD). Valves with headloss greater than 10-inches will significantly decrease the internal recycle pump flow capacity and will be rejected during the submittal process.
- H. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering swing check valves which may be incorporated in the work are:
 - 1. ValMatic Series 500A
 - 2. Dezurik/Apco CSD Style 800 (slanting disc check valve)
 - 3. Kennedy Swing Check

2.19 INLINE RUBBER CHECK VALVES

- A. Check Valves are to be all rubber and the flow operated check type with slip-in cuff connection. The entire Valve shall be ply reinforced throughout the body, saddle and bill, which is cured and vulcanized into a one-piece unibody construction. A separate valve body or pipe used as the housing is not acceptable. The valve shall be manufactured with no metal, mechanical hinges or fasteners, which would be used to secure any component of the valve to a valve housing. The port area of the saddle shall contour into a circumferential sealing area (the “bill”) that is concentric with the pipe which shall allow passage of flow in one direction while preventing reverse flow. The entire valve shall fit within the pipe inside diameter. The saddle area of the valve must be flat, not conical, and integral with the rubber body above centerline in order to not produce any areas or voids that can collect or trap debris. The valve must be easily installed in pipes with poor end condition without the need to modify or utilize the headwall or structure to seal and anchor the valve. Once installed, the Valve shall not protrude beyond the face of the structure or end of the pipe.
- B. The Valve shall incorporate multiple concave grooves molded integrally into the flat saddle wall thickness extending longitudinally a minimum of 80% of the length of the saddle to reduce opening resistance and reduce headloss.
- C. The Valve shall incorporate a custom shaped notch in the end of the bill to reduce cracking pressure. The notch shall be at the invert/bottom of the bill and symmetrical about the valve centerline. The longitudinal length of the notch shall be no greater than half the length of the bill.
- D. The outside diameter of the upstream and downstream sections of the valve must be circumferentially in contact with the inside diameter of the pipe.
- E. Slip-in style Valves will be furnished with a set of stainless steel expansion clamps. The clamps, which will secure the valve in place, shall be installed in the upstream or downstream cuff of the valve, depending on installation orientation, and shall expand outwards by means of a turnbuckle.

Each band shall be pre-drilled allowing for the valve to be pinned and secured into position in accordance with the manufacturer's installation instructions.

F. The Valve shall be made in the USA.

G. Available Manufacturers:

1. CheckMate Ultraflex, Tideflex
2. Or Engineer pre-approved equal.

2.20 GATE VALVES

- A. All above ground gate valves shall be class 150 stainless steel gate valves with handwheel actuators unless noted otherwise in the drawings or valve schedule. Actuators shall indicate the direction to open the valve.
- B. Shell wall thickness shall conform to API 603, ANSI B16.34 Class 150.
- C. Stems shall be graphite or PTFE, per the manufacturer's recommendation for the service installation.
- D. Valves shall be supplied with o-ring seals at all pressure retaining joints. No flat gaskets shall be allowed. Blind bolts shall not be allowed.
- E. Waterway shall be smooth, unobstructed and free of all pockets, cavities and depressions in the seat area.
- F. Valve bodies shall be constructed of stainless steel per A351-CF8M. Bonnet, yoke cap, and wedge shall also consist of stainless steel (A3151-CF8M).
- G. Bolts shall be stainless steel 316.
- H. Valve shall be capable of installation in any position with rated sealing in both directions. Rubber seats of specially compounded SBR material shall be utilized and be capable of sealing under normal conditions. The valve body shall have integral guides engaging integral lugs in the gate in a tongue and groove manner, supporting the gate throughout the entire open/close travel.
- I. Available Manufacturers: Subject to compliance with requirements, manufacturers offering gate valves which may be incorporated in the work are:
 1. Dezurik
 2. Velan

2.21 BURIED BONNETED KNIFE GATE VALVES

- A. All buried gate valve components including: body, bonnet, gate, and stem shall be 304 stainless-steel unless noted otherwise in the drawings or valve schedule. Actuators shall indicate the direction to open the valve.

- B. Seating shall be uni-directional resilient seats for one directional flow, or bi-directional resilient seats for two directional flow.
- C. Bolts shall be stainless steel 316
- D. Waterway shall be smooth, unobstructed and free of all pockets, cavities and depressions in the seat area.
- E. Buried valves shall include 2" nut with valve stem extension to bring the actuating nut to 12" to 6" from finished grade. Stem extension shall be furnished with a valve box and cap to protect the stem, actuator, gear box, and nut.
- F. Available Manufacturers: Shall be made in the USA and subject to compliance with requirements, manufacturers offering buried gate valves which may be incorporated in the work are:
 - 1. DeZURIK Hilton Bonneted Knife Gate Valves (H-200-B)
 - 2. Or equal

2.22 REDUCED PRESSURE (RP) DOUBLE CHECK BACKFLOW PREVENTION VALVE ASSEMBLIES

- A. Double check valve assemblies shall consist of two (2) independent tri-link check modules within a single housing, sleeve access port, four test cocks, and two (2) drip tight shut-off valves (e.g. gate valves).
- B. Check valve shall be removable and serviceable without the need for specialized tools. Check valves shall have reversible elastomer discs and in operation shall produce drip tight closure against reverse flow caused by backpressure or backsiphonage.
- C. Housing shall be constructed of schedule 40 stainless steel (304) pipe with end connections as indicated in the valve schedule and design drawings.
- D. Backflow prevention valve assemblies for the prevention of cross-connection contamination shall be installed per manufacturer requirements and in compliance with all applicable city, county, and state codes and regulations.
- E. Available Manufacturers: Shall be made in the USA and subject to compliance with requirements, manufacturers which may be incorporated in the work are:
 - 1. Watts (Series 757) or equal

2.23 HIGH CAPACITY WATER PRESSURE REDUCING/REGULATING VALVES

- A. Water pressure reducing valve shall include replaceable stainless steel seats, interchangeable diaphragm chambers, and lead free body construction (for potable water service connections).
- B. The valve shall be rated for supply pressures of at least 175 psig and be adjustable on the low-pressure side from 25 to 100 psig.

- C. Valve shall be equipped with 3/8" tapping to receive equalizer piping and a 3/4" tapping to receive auxiliary regulator piping for low flow requirements.
- D. Available Manufacturers: Shall be made in the USA and subject to compliance with requirements, manufacturers which may be incorporated in the work are:
 - 1. Watts (Model LFF 127/127W series) or equal

2.24 BURIED BUTTERFLY VALVES

- A. All buried butterfly valve components including: body, disc, and stem shall be 316 stainless-steel unless noted otherwise in the drawings or valve schedule. Actuators shall indicate the direction to open the valve.
- B. Seating shall be uni-directional resilient seats for one directional flow, or bi-directional resilient seats for two directional flow.
- C. Buried valves shall include 2" nut with valve stem extension to bring the actuating nut to 12" to 6" from finished grade. Stem extension shall be furnished with a valve box and cap to protect the stem, actuator, gear box, and nut.
- D. Available Manufacturers: Shall be made in the USA and subject to compliance with requirements, manufacturers offering buried gate valves which may be incorporated in the work are:
 - 1. DeZURIK
 - 2. Bray
 - 3. 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. Stainless-Steel 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 stainless-steel shapes with MSS SP-58 stainless-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 stainless steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. 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. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use stainless-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. 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.
- K. 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.
- L. 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.
- M. 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-joint 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.
- N. 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.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

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. Codes and Standards:
- B. ANSI Standards:
- C. 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	GREEN
UW	NON-POTABLE (RECYCLED) WATER	PURPLE
PW	POTABLE WATER	DARK BLUE
WAS	WASTE ACTIVATED SLUDGE	BROWN

Coordinate with the Owner for other 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 220553

SECTION 221030 – 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 220050 – General Pipes and Fittings
- B. Section 221066 – 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 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 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 and pressure Class 250 for pipe fourteen inches to twenty inches and 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. Where indicated in drawings the interior of ductile iron pipe shall be glass lined. 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".
- D. Concrete encased ductile iron pipe shall be coated with the bituminous coating by the manufacturer prior to delivery.

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:
 - a. Megalug Series 1100 for Fittings
 - b. Megalug Series 1700 for Joints
 - c. Megalug Series 3800 for Couplingsproduced by EBAA Iron Inc. or equal.
- 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.
- J. All buried bolts shall be coated with FM grease prior to applying the polyethylene wrap.

END OF SECTION 221030

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SECTION 221050 - 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 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 fittings 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 221050

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SECTION 221060 – 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 220050 – Pipes and Fittings, 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.
- 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: 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: 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 220529 – 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 221060

SECTION 221066 – 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 221030
- C. Plastic Pipe. Section 221040
- D. High Density Polyethylene Pipe and Fittings. Section 221060
- E. HDPE Storm Drain Pipe. Section 221055
- F. Stainless Steel Piping and Tubing. Section 221060
- G. Steel Piping and Fabricated Steel piping. Section 221065
- H. Domestic Water Piping. Section 221116
- I. Sanitary Waste and Vent Piping. Section 221316
- J. 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 Storm 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

$$L = (N \times D \times P^{1/2}) / 7,400$$

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 appurtenances 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 appurtenances 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 appurtenances 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 221066

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," "Braze 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.

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 221116

SECTION 221119 - WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Backflow Preventers.
 - 2. Hose bibs.
 - 3. Yard hydrants.
 - 4. 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 consist of a housing containing a single liquid filtering bag. The housing shall be constructed of 304 stainless steel, with flanged inlet and outlets, and shall be rated for 150 psi at 300°F. The filtering bag shall be a stainless steel 316 wire mesh basket with a minimum mesh size of 20 and shall be capable of treating up to 220 gpm. The water filter shall be by Krystil Klear Filtration 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 221119

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 corrosion-resistant-metal 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 corrosion-resistant-metal 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. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- 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 221316

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. 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.

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.
- 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 and Trim."
- 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 221319

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SECTION 230000 – GENERAL HEATING, VENTILATION, AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes products, assemblies and methods applicable to more than one of the systems specified in DIVISION 23 or shown on the drawings.
- B. Drawings and general provisions of Contract, including General and Special Conditions and Division-1 Specification sections, apply to work of this section.
- C. Refer to other Division 23-sections for ductwork and ductwork accessories required in conjunction with work of this section.

1.2 MATERIALS AND EQUIPMENT

- A. Products: No hazardous material such as lead or asbestos containing material or equipment shall be used in DIVISION 23. Use products of a single manufacturer where two or more units of same class of equipment are required. Use new equipment.

1.3 COMMISSIONING HVAC SYSTEMS:

- A. General Requirements: Provide commissioning of HVAC systems. The purpose of commissioning is to bring the project HVAC system to a state of dynamic operation in accordance with the contract plans and specifications by verifying the operation of individual components, subsystems, and systems.
- B. Commissioning Documentation: The Contractor shall maintain the commissioning documentation in ring binders. Provide commissioning plan and all required forms for review by Engineer. The commissioning documentation shall be organized by system and subsystem when practicable. All pages shall be numbered and a table of contents page shall be provided. The commissioning documentation shall include, but not be limited to, the following:
 - 1. Approved Test and Balance Report for the building (project) being commissioned.
 - 2. All approved shop drawings of HVAC equipment to be commissioned. Shop drawings shall be full size sheets folded as required to fit in binders.
 - 3. All pre-commissioning checklists initialed by indicated personnel organized by system and subsystem.
 - 4. All functional performance test checklists signed by indicated personnel organized by system and subsystem.
 - 5. Three copies of the Operation and Maintenance Manuals specified on other sections of these specifications shall be included with the Commissioning Documentation. The manuals shall be incorporated in the Commissioning Documentation prior to the commencement of the training required in this and other sections of the specifications. Preparation of Operation and Maintenance Manuals shall be as specified in other sections of these specifications.

6. HVAC Shop Drawings and As Built Drawings and Specifications shall be assembled after completion of HVAC pre-commissioning phase and prepared as indicated above. Changes as a result of subsequent HVAC Commissioning procedures will be incorporated (as required) at the conclusion of final HVAC Commissioning.
7. The Contractor shall be responsible for maintaining the commissioning documentation until final acceptance of the project. All checklists included in this section of the specifications shall become part of the commissioning documentation. The commissioning documentation shall be kept current by the contractor and shall be available for inspection at all times. At the time of acceptance of the project, the Contractor shall furnish 3 copies of the commissioning documentation to the Owner's representative.

1.4 DESCRIPTION OF WORK:

- A. The following HVAC equipment will be provided and installed by the Contractor per this section and as shown in the drawings.
 1. Provide wall mounted air conditioner(s) as noted in drawings.
 2. Provide exhaust fans as noted in drawings.
 3. Provide fixed louvers as noted in drawings.
 4. Provide gravity and actuated dampers as noted in drawings.
 5. Provide all other HVAC equipment as shown in the drawings.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of HVAC equipment of the types materials, and sizes required, whose products have been in satisfactory use in similar services.
- B. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects with HVAC equipment work similar to that required for this project.
- C. Codes and Standards:
 1. Refrigeration systems shall be constructed in accordance with ASHRAE Standard ASHRAE 15 "Safety Code for Mechanical Refrigeration".
 2. Refrigeration systems shall meet or exceed the minimum COP/Efficiency levels as prescribed in ASHRAE 90A "Energy Conservation in New Building Design".
 3. Refrigeration units shall be listed by UL and have UL label affixed.

1.6 SUBMITTALS:

- A. All submittals shall be made to the Engineer in accordance with Section 013300, Contractor Submittals.
- B. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model, clearly indicated weights, dimensions, required clearances, and methods of assembly of components, furnished specialties and accessories; and installation and start-up instructions.

- C. Wiring Diagrams: Submit ladder-type wiring diagrams for power and control wiring required for final installation equipment and control. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of HVAC equipment, indicating materials and methods of assembly of components.
- E. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 017823.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle HVAC equipment and components carefully to prevent damage, breaking, denting, and scoring. Do not install damaged packaged equipment or components; replace with new.
- B. Store packaged HVAC equipment and components in clean dry place off the ground. Protect from weather, dirt, fumes, water construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading packaged HVAC equipment and moving them to final location for installation.

1.8 MAINTENANCE

- A. Provide first year of all manufacturer's recommended preventive maintenance for all mechanical equipment, including oil change on compressors, filter replacement and cleaning for all mechanical equipment.

PART 2 - PRODUCTS

2.1 HVAC SCHEDULE:

- A. All HVAC equipment is located in the HVAC SCHEDULE in the drawings. The schedule contains the location, service, capacity/size, and models. Where no model is indicated, the Contractor shall appropriately size the equipment and submit it to the Engineer for approval.

2.2 PIPE AND FITTINGS

- A. Refer to individual section for piping materials and fittings requirements.

2.3 PIPING SPECIALTIES

- A. Unions: 2" and smaller; ground joint, malleable iron type. 2-1/2" and larger; flange type, 150# ANSI forged steel. Anvil International, Crane, Walworth, Syspac.
- B. Access Panels: Same type and construction as those specified in Architectural Section or as suitable for the type of ceiling or wall construction. Elmdor, J.L. Industries or Milcor with screwdriver operated lock where not specified in other sections. Stainless steel access panels in tile walls.

C. Escutcheon: Chrome plated steel, heavy pattern with springs for floor and ceiling. Pasco, Proflo.

2.4 MECHANICAL SUPPORTING DEVICES

A. Pipe Hangers: Adjustable threaded rod type in accordance with MSS SP-58, MSS SP-69, and ANSI B31.1, Superstrut, Anvil International. Rod size and spacing shall be as scheduled.

Hanger Rods - Size and Spacing
 Schedule Maximum Hanger Spacing
 Water and Waste

Pipe	Weight Per Foot	Minimum Hanger Rod Size	PVC	Type L Copper
1/2"	1.0	1/4"	4'	6'
3/4"	1.4	1/4"	4'	8'
1"	2.1	1/4"	4'	8'
1-1/4"	2.9	3/8"	4'	10'
1-1/2"	3.6	3/8"	4'	10'
2"	5.2	3/8"	4'	10'

B. Concrete Inserts: Malleable iron body and nut, Anvil International , Superstrut.

C. Duct Hangers: In accordance with SMACNA Duct Construction Standards, Low Pressure or High Pressure as appropriate.

2.5 VIBRATION ISOLATION

A. Equipment: Provide by equipment manufacturer as shown on drawings and installed in accordance with manufacturer's recommendations. Coordinate vibration isolators with equipment supplied.

2.6 MOTORS

A. Requirements: See Section 230513 Common Motor Requirements for HVAC Equipment.

2.7 MOTOR STARTERS

A. Requirements: See DIVISION 26

2.8 VARIABLE FREQUENCY DRIVES (VFD)

A. Requirements: See DIVISION 26

2.9 POWER WIRING

A. Requirements: See DIVISION 26.

2.10 CONTROL WIRING

- A. Requirements: Provide in accordance with requirements of controlled equipment.

2.11 IDENTIFICATION

- A. Equipment Nameplates: Black bakelite, 1-1/2" x 3" with white 1/4" lettering with equipment schedule designations (e.g. "AHU-1 AIR HANDLING UNIT").
- B. Pipe Marking: Semi-rigid plastic coil markers with written legend, color-coded background and flow arrow, all in accordance with ANSI A13.1. Letters to reflect drawing legend designations.

2.12 TESTING AND ADJUSTING

- A. Requirements: Prior to balancing and occupancy, test and adjust all fans, pumps, coils, temperature controls, etc., for proper operation. Recheck all equipment and systems after balancing is complete to confirm operation of all systems is in accordance with plans and specifications. See Section 230593 "Test, Adjust, and Balance of Air & Water Systems" for additional requirements.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install HVAC equipment in accordance with manufacturer's installation instructions. Install units plumb and level, unless otherwise recommended by manufacturer, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

3.2 CUTTING AND PATCHING

- A. General Contractor: Openings in new construction provided by General Contractor for mechanical under direction of the Contractor.

3.3 PIPE AND PIPE FITTINGS

- A. Pipes: Remove burrs by reaming. Use Teflon tape on male threads only.
- B. Openings in Pipes: Keep closed during progress of work.
- C. Coordination: Install so as not to interfere with light fixtures or other trade components.
- D. Close Nipples: Not permitted on any part of work. Use standard short nipples for short pipe connections. Use of bushings not permitted. Piping of Copper Tubing: Continuous. Copper tubing inserts in runs of steel pipe not permitted. Solder joints in copper piping. Do not lay copper tubing on rocks or gravel.
- E. Connections Between Pipes of Dissimilar Metals: Make with insulating unions. (Dielectric.) Include cast iron valve connections to adaptors for copper pipe. Does not apply to waste piping
- F. Cutting of Copper Pipe: Use a cutter. Smooth sharp edges with emery cloth.

- G. Saddles on Pipe and Bending of Pipe: Not permitted.
- H. Equipment Isolation: Provide isolation valves (gate or ball valve) and unions at piping connections to all equipment.
- I. Concealed Piping: Conceal all piping in finished areas unless otherwise noted.

3.4 PIPING SPECIALTIES

- A. Unions: Install at final connections to equipment and on control side of all valves in mains, branches and risers.
- B. Escutcheons: Install at all places where exposed piping passes through walls, floors or ceilings.
- C. Equipment, Valves and Piping: Tag for identification, indicating equipment, zone and area served. Provide nameplates for access doors and removable ceiling panels to areas containing mechanical equipment, valves, etc. Submit to Engineer for approval proposed list of nameplates.
- D. Pipe Sleeves: Install wherever piping passes through floors, footings or walls of concrete or masonry construction. Sleeves to be not less than 20 gauge galvanized steel or molded polyethylene and to be cast in the concrete. Sleeves for insulated pipe shall be of sufficient size to allow the covering to pass through sleeve. Caulk annular space between pipe and sleeve with an oil and resin base type sealant conforming to Fed. Spec. TT-C-598. In lieu of the above sleeving method, an alternate UL listed cast-in-place, sleeving method such as "ProSet" is allowable, provided the system is listed for the application including retaining the integrity of the floor or wall penetration in terms of IBC fire stop performance.
- E. Fire Protection: Fire stop pipe penetrations through fire rated walls, floors and ceilings in accordance with current Building Code.

3.5 MECHANICAL SUPPORTING DEVICES

- A. General: Mechanical equipment and materials are not to be suspended or supported from pipe, electrical conduit, ceiling systems or any nonstructural member.
- B. Housekeeping Pads: Furnish for all mechanical equipment which do not specifically require structural bases or inertia pads. Minimum 4" high, concrete, and extended 4" beyond the equipment base dimensions in all directions. Anchor bolts to secure equipment poured in place in pads.
- C. Concrete Anchoring: Use cast inserts in new construction; stamped metal inserts not acceptable. Expansion shields may be used in existing construction; powder actuated inserts are not acceptable.
- D. Pipe Hangers and Supports: Item selections, hanger spacings, rod diameters, and protection shields in accordance with MSS SP-69 and MSS SP-58, unless otherwise indicated. Pipes shall not be hung or supported from each other. Isolate copper water pipes from dissimilar metals; hangers, steel or aluminum studs, etc.
- E. Multiple Pipe Supports: Where a number of pipes are hung with a common support (e.g. trapeze hanger), submit design criteria/calculation.
- F. Structural Attachments: Beam clamps where possible.

- G. Vertical Adjusting Device: Provide on all rigid hangers.
- H. Protection Shield/Protection Saddle: Use on insulated pipe.
- I. Duct Hangers: Install in accordance with SMACNA Duct Construction Standards, Low Pressure or High Pressure as appropriate.

3.6 ACCESS PANELS

- A. Requirements: When not specifically shown on architectural drawings, provide in walls, ceilings, etc., to provide adequate access for service and maintenance of concealed valves, dampers, motors, air vents or any other concealed equipment or accessories. Minimum size 12" x 12".

3.7 IDENTIFICATION

- A. Equipment Nameplates: Affix prominently on equipment except in finished areas where nameplate shall be inside access panel.
- B. Pipe Marking: Where pipe is exposed or accessible, install every 30 feet, at wall or partitions, and at pipe junctions. Lettering oriented to be read from below horizontal centerline.

3.8 CORROSION PROTECTION

- A. General: Equipment where indicated elsewhere in these specifications shall be provided with additional coating as shown below.
- B. Coils:
 - 1. Condenser and evaporator finned tube coils shall be protected with gold colored impregnated polyurethane (BLYGOLD POLUAL XT) coating.
 - 2. Prior to coating, rinse coil to remove dust, dirt or debris. Bent fins shall be adjusted using fin comb. The coil shall then be degreased with pH neutral cleaner and degreaser to remove oils and soiling. Flush the coil with a final rinsing and conditioning solution and allow it to dry before applying the coating.
 - 3. Apply the coating as specified above with air assisted spray equipment, ensuring total penetration and coverage of all surfaces with the manufacturer's recommended film thickness. Coating shall meet the salt spray (ASTM B 117) testing of a minimum 4,000 hour with no blistering. Provide minimum of 3 year warranty for the coating.
- C. Cabinet and Exterior Surfaces:
 - 1. Unit cabinet shall be coated with AMERON PSX 700 and Coating shall meet the salt spray (ASTM B 117) testing of a minimum 5,500 hours with no blistering.
 - 2. All metal surfaces to be coated shall be cleaned and degreased. The Coating shall be applied in strict accordance with the manufacturer's recommendation.
 - 3. After the coating has totally cured, the equipment shall be assembled using care not to damage the coating. Fasteners shall be stainless steel with bonderized rubber washer

attached. Any touchup required shall be performed in accordance with the manufacturer's recommendation.

- D. Outdoor Metal Supports and Hanger: Provide epoxy paint minimum 2 coats, white color on all metal surfaces except those that are specified to be hot-dipped galvanized.

3.9 START-UP:

- A. Provide the services of a factory-authorized service representative to start-up air conditioning equipment in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.10 OPERATING AND MAINTENANCE TRAINING:

- A. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of HVAC equipment. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.

END OF SECTION 230000

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 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.

1.2 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 NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 600 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. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. 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.
- J. 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.

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: Pre-lubricated, 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

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SECTION 233400 - EXHAUST AND VENT FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Special Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of power and gravity ventilator work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Providing and Installation of fans as noted in the HVAC schedule.

1.3 SUBMITTALS

- A. Refer to Division-1 section 013300 "Contractor Submittals" for contractor submittal requirements.

1.4 QUALITY ASSURANCE

- A. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL). Fan shall bear the AMCA certified ratings seal for sound and air performance.

PART 2 - PRODUCTS

2.1 WALL MOUNTED EXHAUST FANS

A. GENERAL:

Provide exhaust fan of type, size and capacity as scheduled and as specified herein.

B. TYPE:

Fan shall be a spun aluminum, wall mounted, belt driven, horizontal centrifugal exhaust ventilator.

C. CONSTRUCTION:

1. Construction: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16-gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The spun aluminum wall flange shall have pre-punched key slot holes and

a mounting template with wall opening location for ease of installation. The windband shall have a rolled bead for added strength. A two piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.

2. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.
3. Motor: Motor shall be Nema design B with class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.
4. Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
5. Belts & Drives: Belts shall be oil and heat resistant, static conducting. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

D. MANUFACTURERS:

1. Fans shall be model ACWB as manufactured by LOREN COOK Company,
2. Or equal.

E. WARRANTY

1. Provide a minimum 12 month manufacturers warranty.

PART 3 - EXECUTION

3.1 INSPECTION

A. GENERAL:

Examine areas and conditions under which exhaust and vent fans are to be installed.

3.2 INSTALLATION OF FANS

A. GENERAL:

Except as otherwise indicated or specified, install fans in accordance with manufacturer's installation instructions and recognized industry practices to ensure that products serve the intended function.

B. Coordinate work with work of roofing, walls and ceilings, as necessary for proper interfacing.

C. CONTROL DAMPERS:

Install control dampers and mount damper motors.

3.3 ADJUSTING AND CLEANING:

A. CLEANING:

Clean factory-finished surfaces.

B. Adjust and tighten belts and sheaves.

C. Check and adjust clearances between fan and fan housing.

D. Provide lubrication.

END OF SECTION 233400

SECTION 239000 - FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fixed, extruded-aluminum and formed-metal louvers.
- B. Related Requirements:
 - 1. Section 081113 "Hollow Metal Doors and Frames" for louvers in hollow-metal doors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 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.
- C. Samples: For each type of metal finish required.
- D. Delegated-Design Submittal: For louvers indicated to comply with structural performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on tests performed according to AMCA 500-L.
- B. Windborne-debris-impact-resistance test reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade shall pass basic-protection, large-missile testing requirements in ASTM E 1996 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than louvers indicated for use on Project.

- B. 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.

2.2 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Ruskin Company; Tomkins PLC.
 - b. American Warming and Ventilating; a Mestek company.
 - c. Louvers & Dampers; a division of Mestek, Inc.
 - d. Krueger, Division of Air System Components
 - e. Or Equal.
2. Louver Depth: 4 inches.
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
4. Mullion Type: hidden
5. Louver Performance Ratings:
 - a. Point of Beginning Water Penetration: Not less than 900 fpm.
6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.3 LOUVER SCREENS

A. General: Provide screen at louvers indicated.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening.

B. Louver Screen Frames: Same type and form of metal as indicated for louver to which screens are attached.

C. Louver Screening for Aluminum Louvers:

1. Bird Screening: Stainless steel, 1/2-inch- square mesh, 0.047-inch wire.

2.4 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. Galvanized-Steel Sheet: ASTM A 653/A 653M, G60 zinc coating, mill phosphatized.

- D. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. Use Phillips flat-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 color-finished louvers, use fasteners with heads that match color of louvers.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Color: Selected by Owner.

2.5 FABRICATION

- A. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- B. Join frame members to each other and to fixed louver blades with fillet welds , threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.6 FINISHES

- A. Finish louvers after assembly.
- B. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating compatible with coating to be applied over it. Clean welds, mechanical connections, and abraded areas and repair according to ASTM A 780.
- C. 70% Kynar finish meeting AAMA 2605-05 for organic coatings with a 20-year warranty.
 - 1. Color: Selected by Owner from manufacturers standard line.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate and place louvers 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. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

- D. Protect unpainted galvanized and nonferrous-metal surfaces that are 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.

3.2 ADJUSTING

- A. Restore louvers 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.

END OF SECTION 239000

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 GE-01 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 most strict 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 01 33 00 "Contractor Submittals". 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 01 78 23 "Operation and Maintenance Data".

- 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 01 33 00 "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: Type the type of facility this is for such as "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.

2.6 SPECIAL TOOLS

- A. The Electrical Contractor shall furnish a priced list of special tools required to maintain the electrical equipment provided. The Owner and Engineer will select which tools are to be purchased and the IS will supply them at the prices listed.
- B. Special tools shall be delivered to the Owner before startup commences.

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 26 05 53 "Identification for Electrical Systems".
- K. Installation of the I&C System shall be according to the finalized Loop Drawings.

3.4 MOTOR CONTROL TEST (MCT)

- A. The MCT shall consist of a test of all networked power and motor control devices (MCC's, VFD's, etc.) in the factory environment. The MCT shall be conducted at a facility within 200 driving miles of the project site.
- B. The Contractor shall assemble at the test site, for this test, the following:
 1. All networked VFD's and associated switches.
 2. All networked MCC's and associated switches.

3. All PLC's which are to communicate with the devices above.
 4. Any other networked devices.
- C. Provide electric power, networking, and provisions for the Owner's Programmer to connect a temporary SCADA server to the networked devices.
- D. The test can be combined with the FAT's specified in Section 409000, or run independently. If need be for construction sequencing or schedule considerations, the PLC's for the MCT may consist of control panel backpanels including the PLC's, and the control panel enclosures can be shipped to the site.
- E. In advance of the MCT, each manufacturer shall provide a complete list of available registers/signal interfaces and recommended means of effecting basic monitoring and control. Coordinate among vendors, with the IS, and with the Owner's Programmer, and cooperate in configuring all devices prior to testing.
- F. As a formal submittal prior to the MCT, submit details of the location, the intended interconnection. Provide test procedures/checkoffs which will demonstrate that all networked interfaces function as intended.
- G. Allow the following for the MCT.
1. Contractor setup: As required.
 2. Programmer advance setup connection: 1 day.
 3. MCT: 3 days.
 4. Corrections: As required.

3.5 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.

3.6 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.

3.7 CALIBRATION

- A. As specified in Section 40 80 00 "Commissioning of Process Systems".

3.8 LOOP TESTING

- A. As specified in Section 40 80 00 "Commissioning of Process Systems".

3.9 COMMISSIONING

- A. As specified in Section 40 80 00 "Commissioning of Process Systems".

3.10 TRAINING

- A. Provide training in accordance with Section 26 00 00 “General Electrical Requirements”.
- 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

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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 water tight 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 non-insulated, 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 sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.
- 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 Crawlspace: 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 un-spliced conductors.
 - N. Wiring at Outlets and Switches: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.
- 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 26051

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 bare 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 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.
 10. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- 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 SCOPE OF WORK

- A. Supports, anchors, sleeves, and seals, are indicated on the Contract Drawings, schedules, and specified in other sections of these Contract Documents.
- B. Types of supports, anchors, sleeves and seals specified in this section include the following:
 - 1. One-hole Conduit Straps
 - 2. One-Hole Conduit Straps with Clamp Backs
 - 3. Two-Hole Conduit Straps
 - 4. Conduit Hangers
 - 5. I-beam Clamps
 - 6. Channel Clamps
 - 7. Round Steel Rods
 - 8. Drop-in Anchors
 - 9. Wedge Type Anchor Bolts
 - 10. Lead Expansion Anchors
 - 11. Toggle Bolts
 - 12. Wall and Floor Seals
 - 13. Cable Supports
 - 14. U-Channel Strut System
 - 15. Sleeves

1.2 SUBMITTALS

- A. Products shall be submitted in accordance with Section 26000, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Abbeon Cal Inc.
 - 2. Ackerman Johnson Fastening Systems Inc.
 - 3. Elcen Metal Products Co.
 - 4. Ideal Industries, Inc.
 - 5. Josyln Mfg and Supply Co.
 - 6. McGraw Edison Co.
 - 7. Rawlplug Co. Inc.

8. Star Expansion Co.
9. U.S. Expansion Bolt Co.
10. Allied Tube and Conduit Corp.
11. B-Line Systems, Inc.
12. Greenfield Mfg Co., Inc.
13. Midland-Ross Corp.
14. O-Z/Gedney Div; General Signal Corp.
15. Power-Strut Div.; Van Huffel Tube Corp.
16. and Unistrut Div; GTE Products Corp.
17. Robroy Industries.

2.2 GENERAL

- A. Provide supporting devices that comply with manufacturer standard materials, design, and construction, in accordance with published product information, and as required for complete installations, and as specified herein.

2.3 SUPPORTS

- A. Provide supporting devices of types, sizes, and materials indicated, and having the following construction features:
 1. One-Hole Conduit Straps: For supporting electrical metallic tubing, and liquid tight flexible conduit; zinc plated steel, stainless steel or galvanized steel; snap-on, heavy duty.
 2. One-Hole Conduit Straps with Clamp Backs: For supporting rigid metal conduit, and intermediate metal conduit; cast galvanized steel.
 3. Two-Hole Conduit Straps: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
 4. Conduit Hangers: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
 5. I-Beam Clamps: Electroplated zinc or hot dipped galvanized malleable iron.
 6. Channel Clamps: Electroplated zinc or hot dipped galvanized steel.
 7. Round Steel Rod: National coarse thread, electroplated.

2.4 ANCHORS

- A. Provide anchors of types, sizes, and materials indicated, with the following construction features:
 1. Lead Expansion Anchors: For CMU walls, ¼ inch - 20 threads, set tool required.
 2. Toggle Bolts: Electroplated steel, size as required.
 3. Drop-in Anchors: Stainless steel, size as required.
 4. Anchor Bolts: Stainless steel, size as required.
 5. Lag Bolts: Stainless steel, size as required.
 6. Half-round head, non-removable anchor bolts shall not be used.
 7. Self-Tapping screws shall not be used.

2.5 SEALS

- A. Provide seals of types, sizes and materials indicated; with the following construction features:
1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sized indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
 2. Conduit sealing bushings shall be manufactured by O-Z/Gedney, Model CSMI, or approved equal.
 3. The conductor sealing bushings shall be manufactured by O-Z/Gedney, Model CSBG, or approved equal.

2.6 CONDUIT CABLE SUPPORTS

- A. Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct 2 inch rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

2.7 U-CHANNEL STRUT SYSTEM

- A. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16 inch dia. holes, 8 inch o.c. on top surface, with the following fittings that mate and match with U-Channel.
1. Fixture hangers
 2. Channel hangers
 3. End caps
 4. Beam clamps
 5. Wiring stud
 6. Thinwall conduit clamps
 7. Rigid conduit clamps
 8. Post Bases
 9. U-bolts
- B. Approved for use with the following types of conduit:
1. EMT
 2. IMT
 3. GRS
 4. PVC (where above conduits are approved for the same location.)

2.8 PIPE SLEEVES

- A. Provide pipe sleeves from the following:
1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

2.9 PVC COATED U-CHANNEL STRUT SYSTEM

- A. Provide PVC Coated U-channel strut system for supporting electrical equipment, 20 mil PVC coated steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all Stainless Steel hardware, and the following fittings that mate and match with PVC Coated U-Channel:
 - 1. PVC Coated Strut nut
 - 2. PVC Coated Pipe straps
 - 3. Touch up compound (Gray)
- B. Approved for use with the following types of conduit:
 - 1. PVC Coated GRS
 - 2. Aluminum
 - 3. PVC

2.10 STAINLESS STEEL U-CHANNEL STRUT SYSTEM

- A. Provide Stainless Steel U-channel strut system for supporting electrical equipment, of types and sizes indicated; construct with 9/16 inch dia. holes, 8 inch o.c. on top surface, with all stainless steel hardware, and the following stainless steel fittings that mate and match with Stainless Steel U-Channel:
 - 1. Fixture hangers
 - 2. Channel hangers
 - 3. End caps
 - 4. Beam clamps
 - 5. Wiring stud
 - 6. Post bases
 - 7. Rigid conduit clamps
 - 8. U-bolts
- B. Approved for use with the following types of conduit:
 - 1. PVC Coated GRS
 - 2. PVC

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

- C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of 2 or more parallel runs of conduits to be supported together on channel type hangers where possible. Install supports with spacing indicated and in compliance with NEC requirements.
- D. Torque sleeve seal nuts, complying with manufacturer recommended values. Ensure that sealing grommets expand to form watertight seal.
- E. Comply with manufacturer's recommendations for touch up of field cut ends or damaged PVC coated U-channel and fittings.
- F. Remove burrs and apply a cold zinc galvanizing paint to field cut galvanized U-channel strut prior to installation.
- G. Provide a minimum of two anchors per piece of u-channel. Maximum spacing of anchors shall be 12 inch o.c.

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 Stainless Steel unless specifically indicated otherwise on the Plans. Conduits in corrosive, hazardous, or damp areas shall be Stainless Steel unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC, 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. A half-lapped rapping of 20 mil PVC based corrosion protection tape shall be used.

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, 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, galvanized steel 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.
- 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. Connectors for liquidtight flexible conduit shall be galvanized, furnished with a sealing ring and locknut, and suitable for wet locations.

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 conduit is approved for wet and corrosive areas only. Prior approval from the engineer must be obtained when substituting for PVC coated.
- B. 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.
- C. 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.
- 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 availability of 6, 9, and 12-inch 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 Hot Dipped galvanized materials. All cuts and welds shall be touched up with cold galvanizing spray per the raceway specification.
 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 conduit 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 galvanizing, or other 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. IMC or GRS shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying fittings. A zinc rich cold galvanizing shall be used to restore corrosion protection on field cut threads.
- 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 26000 “General Electrical Requirements”, and elsewhere in the Contract Documents, prior to installation.

1.4 MANUFACTURERS

- A. Enclosures shall be manufactured by Hoffman, Rittal, or 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 enclo-

ures 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 Waste Water 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.

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.

END OF SECTION 260534

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fiberglass cable trays.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of cable tray.
- C. Delegated-Design Submittal: For seismic restraints.
 - 1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Component Importance Factor: 1.5.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.3 FIBERGLASS CABLE TRAYS

- A. Description:
 - 1. Configuration: Two longitudinal members with rounded edges and smooth surfaces, complying with NEMA FG 1.
 - 2. Materials: Straight section structural elements; side rails, rungs and splice plates shall be pultruded from glass-fiber-reinforced polyester or vinyl ester resin, complying with NEMA FG 1 and UL 568.
 - 3. Fasteners: Fiberglass-encapsulated, ASTM F 593 and ASTM F 594 stainless steel, Type 316. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation shall not be damaged when torqued to manufacturer's recommended value.
 - 4. Minimum Usable Load Depth: As indicated on Drawings. according to NEMA FG 1.
 - 5. Straight Section Lengths: As indicated on Drawings.
 - 6. Width: As indicated on Drawings.
 - 7. Class Designation: Comply with NEMA VE 1.
 - 8. Temperature Rating: Reduce the load rating of tray exposed to temperatures above 75 deg F according to Table 4-3, "Working Loads," in NEMA FG 1.
 - 9. Fitting Minimum Radius: As indicated on Drawings.
 - 10. Splicing Assemblies: Minimum four nuts and bolts per plate. Splice plates shall be furnished with straight sections and fittings.
 - 11. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 MATERIALS AND FINISHES

- A. Fasteners: Electrogalvanized before fabrication and painted with an epoxy-resin or power-coat enamel paint.

2.5 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: Will not be required for this project

- C. Barrier Strips: Same materials and finishes as for cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

- A. Lettering: 1-1/2-inch high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA FG 1
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Fasten cable tray supports to building structure and install seismic restraints.
- D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."
- E. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- F. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- G. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.
- H. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- I. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

- J. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15,000 V.
- K. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- L. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.
- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

END OF SECTION 260536

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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. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. 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 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- 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-vegetation 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 steel 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 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.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
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 rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
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 ductbank 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.
2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products 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."

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. 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: Galvanized 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. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 2. 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.
 - 3. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 4. Pressure Plates: Stainless steel.
 - 5. 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. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 2. 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).
 - 3. Sealant 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. 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 **steel** pipe 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 cast-iron 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

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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 (50 mm) 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 260573 – ELECTRICAL TESTING WITH COORDINATION STUDY

PART 1 – GENERAL

1.1 SCOPE

- A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E. The arc flash hazard analysis shall be performed according to the IEEE 1583 equations that are presented in NFPA 70E-2004, Annex D.
- C. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract as well as all existing distribution equipment at the customer facility.
- D. The contractor shall perform electrical tests as described in Part 3 of this document.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American National Standards Institute (ANSI):
 - a. 450, Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generator Stations and Substations.
 - b. C2, National Electric Safety Code.
 - c. C37.13, Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
 - d. C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
 - e. C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear.
 - f. C37.20.3, Metal-Enclosed Interrupter Switchgear.
 - g. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
 - h. C62.33, Standard Test Specifications for Varistor Surge Protective Devices.
 - 2. American Society for Testing and Materials (ASTM):
 - a. D665, Standard Test Method for Rust Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water.
 - b. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
 - c. D923, Standard Test Method for Sampling Electrical Insulating Liquids.
 - d. D924, Standard Test Methods for A-Class Characteristics and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
 - e. D971, Standard Test Method for Interfacial Tension of 0.1 against Water by the Ring Method.

- f. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
 - g. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
 - h. D1500, Standard Test Method for ASTM Color of Petroleum Products.
 - i. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
 - j. D1533, Standard Test Methods for Water in Insulating Liquids.
 - k. D1816, Standard Test Method for Dielectric Breakdown Voltage on Insulating Oils of Petroleum Origin Using VDE Electrodes.
 - l. D2285, Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin against Water by the Drop-Weight Method.
3. Institute of Electrical and Electronics Engineers (IEEE):
- a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
 - b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.
 - c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - d. 95, Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.
 - e. 118, Standard Test Code for Resistance Measurement.
 - f. 141, Recommended Practice for Electric Power Distribution and Coordination of Industrial Power Systems.
 - g. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - h. 399, Recommended Practice for Industrial and Commercial Power System Analysis
 - i. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.
 - j. 1015, Recommended Practice for Apply Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
 - k. 1584, Guide for Performing Arc-Flash Hazard Calculations
4. National Electrical Manufacturers Association (NEMA):
- a. AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
 - b. PB 2, Deadfront Distribution Switchboards.
 - c. WC 7, Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - d. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
5. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Fire Protection Association (NFPA):

- a. 70, National Electrical Code (NEC).
- b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.3 SUBMITTALS

- A. Analysis Studies Submittal: Submit prior to receiving final approval of the distribution equipment submittal and prior to release of equipment manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval may be obtained from the Engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
1. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report and submitted to the Design Engineer
 2. The report shall include the following sections:
 - a. Executive Summary
 - b. Descriptions, purpose, basis and scope of the study
 - c. Tabulations of circuit breaker, fuse and other protective device ratings versus short circuit duties
 - d. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trips unit settings, fuse selection
 - e. Fault current calculations including a definition of terms and guide for interpretation of the computer printout\
 - f. Details of the incident energy and flash protection boundary calculations
 - g. Recommendations for system improvements, where needed
 - h. One-line diagram
 3. Arc flash labels shall be provided in hard copy only
 4. Sample copy of individual device test form.
 5. Sample copy of individual system test form.
- B. Administrative Submittals: Submit 30 days prior to performing inspections or tests:
1. Schedule for performing inspection and tests.
 2. List of references to be used for each test.
 3. Sample copy of equipment and materials inspection form(s).
 4. Sample copy of individual device test form.
 5. Sample copy of individual system test form.
- C. Quality Control Submittals: Submit within 14 days after completion of test:
1. Test or inspection reports and certificates for each electrical item tested.
- D. Contract Closeout Submittals:
1. Operation and Maintenance Data:
 - a. In accordance with references elsewhere in these specifications.
 - b. After test of inspection reports and certificates have been reviewed by ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.4 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- B. The Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.
- C. The Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- D. The Engineer shall submit references of at least ten actual short-circuit, protective device coordination and arc flash hazard analysis studies performed over the last five years.

1.5 QUALITY ASSURANCE

- A. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
- B. Test instrument calibration shall be in accordance with NETA ATS.

1.6 SEQUENCING AND SCHEDULING

- A. Perform short-circuit, protective device coordination and arc flash hazard analysis studies prior to final approval of distribution equipment submittal
- B. Perform inspection and electrical tests after equipment has been installed.
- C. Perform tests with apparatus de-energized whenever feasible.
- D. Inspection and electrical tests on energized equipment are to be:
 - 1. Scheduled with OWNER prior to de-energization.
 - 2. Minimized to avoid extended period of interruption to the operating plant equipment.
- E. Notify OWNER at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 – PRODUCTS

2.1 STUDIES

- A. Contractor is to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E Article 130.3 and Annex D.

2.2 DATA COLLECTION

- A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination may include present and future motors and generators
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.
- B. Transformer design impedances shall be used when test impedances are not available.
- C. Provide the following:
 1. Calculation methods and assumptions
 2. One-line diagram of the system being evaluated
 3. Source impedance data, including utility system and motor fault contribution characteristics
 4. Tabulations of calculated quantities
 5. Results, conclusions, and recommendations.
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 1. Electric utility's supply termination point
 2. Incoming switchgear
 3. Unit substation primary and secondary terminals
 4. Low voltage switchgear
 5. Motor control centers
 6. Standby generators and automatic transfer switches
 7. Branch circuit panelboards
 8. Other significant locations throughout the system
- E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Protective Device Evaluation
 1. Evaluate equipment and protective devices and compare to short circuit ratings
 2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
 3. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs
- B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
- D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the TCC graphs, where applicable:
 1. Electric utility's overcurrent protective device
 2. Medium voltage equipment overcurrent relays
 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
 6. Conductor damage curves
 7. Ground fault protective devices, as applicable
 8. Pertinent motor starting characteristics and motor damage points, where applicable
 9. Pertinent generator short-circuit decrement curve and generator damage point
 10. The largest feeder circuit breaker in each motor control center and applicable panelboard
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model.

Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

- A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
 2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
 3. Reactor data, including voltage rating, and impedance.
 4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X''_d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
 5. Motor contribution data (induction motors and synchronous motors), including shortcircuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
- B. Short-Circuit Output Data shall include, but not be limited to the following reports:
1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Equivalent impedance
 2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated symmetrical fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Calculated asymmetrical fault currents
 - e. Equivalent impedance
 3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated symmetrical fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. No AC Decrement (NACD) Ratio
 - e. Equivalent impedance
 - f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers
- C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
 - a. Current transformer ratio
 - b. Current setting
 - c. Time setting
 - d. Instantaneous setting
 - e. Recommendations on improved relaying systems, if applicable.
 2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground)
 - b. Adjustable time-current characteristic
 - c. Adjustable instantaneous pickup
 - d. Recommendations on improved trip systems, if applicable.
- D. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 – EXECUTION

3.1 GENERAL

- A. Tests specified in this section are to be performed in accordance with the requirements elsewhere in these specifications.
- B. Coordination with local Utilities to obtain necessary information to perform the tests specified in this section is the responsibility of the Contractor. All costs incurred in obtaining required information shall be borne by the Contractor.
- B. Tests and inspection shall establish that:
 1. Electrical equipment is operational within industry and manufacturer's tolerances.
 2. All trip units are adjusted to avoid erroneous tripping of circuit breakers.
 2. Installation operates properly.
 3. Equipment is suitable for energization.
 4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.
- C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- D. Adjust mechanisms and moving parts for free mechanical movement.
- E. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
- F. Verify nameplate data for conformance to Contract Documents.
- G. Realign equipment not properly aligned and correct un-levelness.
- H. Properly anchor electrical equipment found to be inadequately anchored.
- I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.
- J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- K. Provide proper lubrication of applicable moving parts.
- L. Inform OWNER of working clearances not in accordance with NFPA 70.

- M. Investigate and repair or replace:
 - 1. Electrical items that fail tests.
 - 2. Active components not operating in accordance with manufacturer's instructions.
 - 3. Damaged electrical equipment.

- N. Electrical Enclosures:
 - 1. Remove foreign material and moisture from enclosure interior.
 - 2. Vacuum and wipe clean enclosure interior.
 - 3. Remove corrosion found on metal surfaces.
 - 4. Repair or replace, as determined by OWNER, door and panel sections having dented surfaces.
 - 5. Repair or replace, as determined by OWNER, poor fitting doors and panel sections.
 - 6. Repair or replace improperly operating latching, locking, or interlocking devices.
 - 7. Replace missing or damaged hardware.
 - 8. Finish:
 - a. Provide matching paint and touch up scratches and mars.
 - b. If required due to extensive damage, as determined by OWNER, refinish the entire assembly.

- O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

3.2 COORDINATION STUDY FIELD ADJUSTMENT

- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify Owner in writing of any required major equipment modifications.

3.3 ARC FLASH WARNING LABELS

- A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy
 - 6. Working distance

- D. Labels shall be machine printed, with no field markings.
- E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 600, 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
 - 2. For each motor control center, one arc flash label shall be provided.
 - 3. For each low voltage switchboard, one arc flash label shall be provided.
 - 4. For each switchgear, one flash label shall be provided.
 - 5. For medium voltage switches one arc flash label shall be provided

3.4 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

- 1. Inspect Each Individual Exposed Power Cable No. 4 and Larger For:
 - a. Physical damage.
 - b. Proper connections in accordance with single-line diagram.
 - c. Cable bends that do not conform with manufacturer's minimum allowable bending radius where applicable.
 - d. Color coding conformance with specifications.
 - e. Proper circuit identification.
- 2. Mechanical Connections For:
 - a. Proper lug type for conductor material.
 - b. Proper lug installation.
 - c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
- 3. Shielded Instrumentation Cables For:
 - a. Proper Shield grounding.
 - b. Proper terminations.
 - c. Proper circuit identification.
- 4. Control Cables For:
 - a. Proper termination.
 - b. Proper circuit identification.
- 5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

- 1. Insulation Resistance Tests:
 - a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.
 - b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
 - c. Insulation resistance values equal to, or greater than ohm values established by manufacturer.
 - d. Provide test reports to Engineer and Owner that show where test measurements were taken and the results
- 2. Contact Resistance Tests:
 - a. Contact resistance in micro-ohms across each switch blade and fuse holder.
 - b. Investigate deviation of 50% or more from adjacent poles or similar switches.

3.5 MOLDED CASE CIRCUIT BREAKERS

- A. General: Inspection and testing limited to circuit breakers rated 400 amperes and larger.
- B. Visual and Mechanical Inspection:
 - 1. Proper mounting.
 - 2. Proper conductor size.
 - 3. Feeder designation according to nameplate and one-line diagram.
 - 4. Cracked casings.
 - 5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
 - 6. Operate frame size and trip setting with circuit breaker schedules or one-line diagram.
 - 7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
 - 8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.
- C. Electrical Tests:
 - 1. Insulation Resistance Tests:
 - a. Utilize 1,000-volt dc megohm-meter for 480- and 600-volt circuit breakers.
 - b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
 - c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
 - d. Test values to comply with NETA ATS, Table 10.2.
 - 2. Contact Resistance Tests:
 - a. Contact resistance in micro-ohms across each pole.
 - b. Investigate deviation of 50% or more from adjacent poles and similar breakers.
 - 3. Trip Coordination Study:
 - a. Provide coordination study of all new and existing equipment in the facility.
 - b. Adjust all circuit breaker settings per the coordination study.

3.6 INSTRUMENT TRANSFORMERS

- A. Visual and Mechanical Inspection:
 - 1. Visually Check Current, Potential, and Control Transformers for:
 - a. Cracked insulation.
 - b. Broken leads or defective wiring.
 - c. Proper connections
 - d. Adequate clearances between primary and secondary circuit wiring.
 - 2. Verify Mechanically that:
 - a. Grounding and shorting connections have good contact.
 - b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
 - 3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.7 METERING

- A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify that meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.8 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control centers and panelboards assemblies for proper connection and tightness.
2. Ground bus connections in motor control centers and panelboards assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.
6. Test ground system using 3 point fall of potential test equipment. Ground system must provide less than 5 ohms to ground resistance. Provide test reports to Engineer and Owner that show where test measurements were taken and the results. System must be tested at all ground rods, concrete encased electrodes, ground busses and service entrance locations.

3.9 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 10 hp and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate Motor and Check for:
 - a. Excessive mechanical and electrical noise.
 - b. Overheating.
 - c. Correct rotation.
 - d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for proper operation.
 - e. Excessive vibration.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
 - a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
 - 1) Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.

- 2) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
 - b. Insulation resistance values equal to, or greater than, ohm values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.
5. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

3.10 LOW VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air cooling passages.
5. Proper operation of draw out elements.
6. Integrity and contamination of us insulation system.
7. Check Door and Device Interlocking System By:
 - a. Closure attempt of device when door is in OFF or OPEN position.
 - b. Opening attempt of door when device is in ON or CLOSED position.
8. Check Nameplates for Proper Identification Of:
 - a. Equipment title and tag number with latest one-line diagram.
 - b. Pushbuttons.
 - c. Control switches.
 - d. Pilot lights.
 - e. Control relays.
 - f. Circuit breakers.
 - g. Indicating meters.
9. Verify that fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify that current and potential transformer ratios conform to Contract Documents.
11. Check Bus Connections for High Resistance by Low Resistance Ohmmeter and Calibrated Torque Wrench Applied to Bolted Joints:
 - a. Ohm value to be zero.
 - b. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
12. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems by:
 - a. Closure attempt for locked open devices.
 - b. Opening attempt for locked closed devices.
13. Verify performance of each control device and feature furnished as part of the motor control center.
14. Control Wiring:
 - a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
 - b. Check for proper conductor lacing and bundling.
 - c. Check for proper conductor identification.

- d. Check for proper conductor lugs and connections.
- 15. Exercise active components.
- 16. Inspect Contactors For:
 - a. Correct mechanical operations.
 - b. Correct contact gap, wipe, alignment, and pressure.
 - c. Correct torque of all connections.
- 17. Compare overload heater rating with full-load current for proper size.
- 18. Compare fuse, motor protector, and circuit breaker with motor characteristics for proper size.
- 19. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

- 1. Insulation Resistance Tests:
 - a. Applied megohm-meter dc voltage in accordance with NETA ATS, Table 10.2.
 - b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
 - c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
 - d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
 - e. Test values to comply with NETA ATS, Table 10.2.
- 2. Current Injection through Overload Unit at 300% of Motor Full-Load Current and Monitor Trip Time:
 - a. Trip time in accordance with manufacturer's published data.
 - b. Investigate values in excess of 120 seconds.
- 3. Control Wiring Tests:
 - a. Apply secondary voltage to control power and potential circuits.
 - b. Check voltage levels at each point on terminal boards and each device terminal.
 - c. Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.
 - 1) Insulation resistance to be 1 megohm minimum.
- 4. Operational test by initiating control devices to affect proper operation.
- 5. Provide test reports to Engineer and Owner that show where test measurements were taken and the results

END OF SECTION 260753

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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 manufacturer's 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

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 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. 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 used for the maximum device that can be fitted into them.
- C. 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.

- D. Each panelboard shall have, on the outside of the door, a lamicoïd nameplate with 3/4 inch letters as specified elsewhere in these Contract Documents.
- E. Panelboards shall be as manufactured by Square D, General Electric, Eaton / Cutler Hammer, or equal.
- F. 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 silver or 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 Modbus TCP Ethernet 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. Intelligent MCC shall be equipped with Moxa EDS-510A-1GT2SFP or Moxa EDS-518A. Provide a minimum of four spare copper Ethernet ports for future connections.
- R. MCCs shall be as manufactured by Allen-Bradley, Square D, or approved equal.
- S. Factory test in accordance with manufacturer standard testing. Submit test results.
- T. Undertake an interconnected factory test (Motor Control Test – MCT) as specified in Section 260000. This test requires assembling all networked motor controllers and PLCs in a single location.

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 26 00 00 "General Electrical Requirements".
- F. Motor Control Centers shall be provided in accordance with all applicable sections of division 26 00 00.

3.2 FIELD TESTS

- A. MCCs shall be tested in accordance with Section 26 00 00.

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.

2.11 COMMUNICATIONS OUTLETS

- 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.

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. Pigtailling 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 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers and motor-control centers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

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 NEMA FU 1 for cartridge fuses.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 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. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

- A. Class L Time Delay Fuses: Provide UL Class L time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting transformers, motors, and circuit-breakers.
- B. Class L Fast Acting Fuses: Provide UL Class L fast-acting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting service entrances and main feeder circuit-breakers.
- C. Class RK1 Time Delay Fuses: Provide UL Class RK1 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors and circuit-breakers.
- D. Class RK1 Current Limiting Fuses Provide UL Class RK1 current-limiting fuses rated 250-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit-breakers.
- E. Class J Current Limiting Fuses: Provide UL Class J current-limiting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.
- F. Class RK5 Time Delay Fuses: Provide UL Class RK5 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors.
- G. Class K5 One Time Fuses: Provide UL Class K5 one-time fuses rated 250-volts, 60 Hz, with 100,000 RMS symmetrical interrupting current rating for protecting non-inductive loads.
- H. Class T Fuses: Provide UL Class T fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protection of physically small devices.

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION 262813

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: Conformance 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. Rockwell Automation, Inc.; Allen-Bradley PowerFlex 700 series drives.
- 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).
 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 120 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 variable and set point. These signals shall be setup 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 allow 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. Embedded SCADA Protocols for Network Communications: Modbus TCP protocols 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 than 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 be 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: Field 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.
- D. Factory test in accordance with manufacturer standard testing. Submit test results.
- E. Undertake an interconnected factory test (Motor Control Test – MCT) as specified in Section 260000. This test requires assembling all networked motor controllers and PLCs in a single location.

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 SECTION 262923

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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 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 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	MCO V
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	1200 V	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	1200 V	20kA	320V
277Y 277/480 VAC 3ph, 4W + gnd, wye	200kA	1200V	1200V	2000V	1200 V	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 insure 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	MCO V
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	1200 V	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	1200 V	20kA	320V
277Y 277/480 VAC 3ph, 4W + gnd, wye	150kA	1200V	1200V	2000V	1200 V	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 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 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 inch.
- C. Detailed maintenance instructions shall be printed on the front panel to insure 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	V _{peak} L-N	V _{peak} L-G	V _{peak} L-L	V _{peak} N-G	I _n	MCO V
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 insure 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. Bulb finish: Clear
2. Any burning position

E. Metal Halide Lamps:

1. Bulb finish: Clear
2. Any burning position

F. LED:

1. Lifespan: 50,000 hour
2. Minimum CRI: 85
3. Minimum Color Temperature: 4000K

- 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. HID Lighting Fixtures:

1. Ballasts for high pressure sodium lighting fixtures:
 - a. Type: Regulating
 - b. Ballast design center variance: Maximum 5 percent from rated lamp wattage.
 - c. Lamp wattage regulation spread at the lamp voltage: Maximum 10 percent for +/- 10 percent line voltage variation.
 - d. Ballast primary current during starting not to exceed normal operating current.
 - e. Lamp current crest factor: Maximum 1.8 for +/-10 percent line voltage variation at any lamp voltage, from nominal through life.
 - f. Power factor shall not drop below 90 percent for +/-10 percent line voltage variations at any lamp voltage, from nominal through life.
 - g. Capacitor variance: Tolerance of +/-6 percent which will not cause more than a +/-8 percent variation in regulation throughout rated lamp life for nominal line voltage.
 - h. Capable of operation with an open circuit condition for a maximum of 6 months without significant loss of ballast or starting circuitry life.
2. Ballasts for metal halide/mercury vapor lighting fixtures:
 - a. Type: Auto-regulator
 - b. Voltage input range: +/-10 percent
 - c. Lamp regulation spread: 20 percent maximum

- d. Power factor: 90 to 90 percent
- e. Input voltage dip (4sec.): 40 to 50 percent
- f. Crest factor of lamp current: 1.6 to 2.0
- 3. Ballasts for exterior HID lamps:
 - a. UL approved
 - b. High power factor designed for -20 °F temperature starting
- 4. Fixtures for non-hazardous locations:
 - a. Type: Industrial low bay
 - b. Ballast housing: Die-cast
 - c. Filter: Activated charcoal
 - d. Refractor: UV stabilized molded acrylic

C. 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, weather proof 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

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 024116 "Structure Demolition".

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 District prior to their removal.
 2. Grind down stumps and remove roots, 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 satisfactory soil material unless further excavation or earthwork is indicated.
1. 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. Stockpile site gravel at an Owner's designated area and re-use in project work.
- 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 311000

SECTION 311100 – FINISH GRADING AND LANDSCAPING

PART 1 - GENERAL

1.01 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.
- C. Revegetation of all cleared or stripped areas disturbed by construction activities

1.02 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.).

1.03 RELATED WORK

- A. Division One - General Requirements.

1.04 SUBMITTALS

- A. Topsoil shall be subject to inspection and approval at the source of supply or upon delivery.

1.05 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

2.01 IMPORTED FILL MATERIALS

- A. As required in Section 312000.

2.03 TOPSOIL

- A. Topsoil shall be fertile, friable, natural loam and shall be capable of sustaining vigorous plant growth. Topsoil shall be approved native soils stripped from the site prior to excavation. It shall be free of stones, lumps, clods of hard earth, plants or their roots, sticks and other extraneous matter. The soil shall contain no noxious weeds or their seeds. It shall not be used for planting operation while in a frozen or muddy condition.

PART 3 - EXECUTION

3.01 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. Finish grade tolerance shall be within plus or minus .15 foot of final grades indicated on drawings.
- D. 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.
- E. Finished grades shall be established to provide after settling, adequate drainage in a uniform way so no water pockets or ridges will be created.

3.02 FINISH GRADING

- A. Fine grade all landscaped areas to a smooth, loose and uniform surface.
- B. Finish grades of all landscaped areas shall be established with topsoil material, as specified, spread to a depth of two (2) inches.
- C. Contractor is responsible to spread excess excavated soil material from plant pits in surrounding planting beds.
- D. Finished grade of planting areas shall be one (1) inch below top of curb, walls, concrete slabs, and mow strips or redwood headers.

3.03 REVEGETATION

- A. Areas indicated for native reseeding shall be brought to finish grade with two (2) inches of top soil on which a native meadow grass and flower seed mix shall be placed. The seed mix shall consist of plants native to the bay area environment and shall not require irrigation systems. Coordinate the final approved seed mixture with Owner including grass/flower species. The applied rate shall be confirmed by a local nursery or landscape architect but is anticipated to range from 5 to 7 pounds of seed mix per acre. Prepare a clean, firm, consistent seed bed by disking. Drill seed ½ to ¼-inch deep. Broadcast seed in areas where drilling is not practical.

END OF SECTION 311100

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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/Engineered fill for building pads, concrete structures and auxiliary structures.
3. Bedding course for pipe and utility trenches.
4. Drainage course.
5. Crusher fines for gravel pathway/walkway applications.
6. Controlled Low Strength Material (CLSM) for structural fill applications.
7. Accessories.
8. Clearing and Grubbing.
9. Excavation for rough grading the site.
10. Excavation for structures.
11. Excavation for piping and utility trenches.
12. 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.
- C. 312319 "Dewatering" for dewatering requirements during excavation and construction activity.
- D. 315000 "Excavation Support and Protection" for additional requirements regarding shoring, bracing, sheeting, trenching, and other protective measures during excavation activities.

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. Crusher Fines: Consist of small particles of crushed rock, typically left from rock crushing operations or ground specifically for trail grading purposes.
- G. 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.
- H. Fill: Soil materials used to raise existing grades.
- I. 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.
- J. 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.
- K. 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 and Owner 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 in accordance with the Geotechnical Report. 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 2 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. For clarification, the results of the Miller Pacific report (see Section 319000) regarding stockpile material onsite have been reviewed with the Geotechnical engineer. Per the report, material from areas where composite samples #2 and #3 were taken are reasonably close to requirements for certain type of site backfill material. Accordingly, stockpile material from areas near these sample locations may be used for the following applications:
 - 1. Subgrade for roadways (excluding the 12" of road base required directly beneath the paved surface).
 - 2. Raising grade on site that is not otherwise beneath roadways, structures, or other improvements.
 - 3. In any application, the material must still meet the minimum density, moisture content, and compaction requirements as noted in this section for each application and its installation is subject to the same inspection and approval as required for any material.

This stockpile material is **not** approved for the following applications:

- 1. Structural backfill beneath structures/slabs that are not on caisson/pier foundation structures (e.g. slabs on grades, shallow foundations, etc.).
- 2. Road base beneath pavement.

Note that stockpile material from the area near composite sample 1 (refer to report in Section 319000) has a much higher plasticity index (49%) and may only be used to raise grade on site that is not beneath structures, roadways, or other improvements. In addition, this material should only be utilized if other sources of available backfill material have already been utilized (e.g. over excavation material, crushed rock, other stockpile material, etc.). This higher plasticity material appears to represent roughly 1/3 of the stockpile material.

- D. 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 including anticipated “bay mud” from excavation activities.
- E. Base Course: Base Course shall conform to CALTRANS Class 2AB material requirements (3/4 inch maximum size).
- F. Structural/Engineered 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.

The contractor may elect to utilize excavated bedrock, crushed rock from landscaping/process basins, and crushed concrete to be demolished as backfill material. In order for this material to be used for structural backfill, it must meet the requirements for structural fill and be sufficiently compactible as required in the design drawings and per the recommendations in the Geotechnical report. Engineer and Owner must approve all onsite material.

Examples of suitable structural fill include:

1. Select Backfill: Suitable material that can be readily compacted and meets the requirements of AASHTO M145 classification A-1-a, non-plastic, well graded with a maximum particle size of 2-inches (in any direction).

<u>Sieve Size</u>	<u>Percentage Passing</u>
2-inch	100
No. 10	30-50
No. 40	15-30
No. 200	0-10

2. Crushed Rock: Manufactured angular, crushed rock, non-plastic, meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
3/8-inch	100
No. 4	30-50
No. 200	0-5

3. Sand Backfill: Sand, non-plastic, **only to be used where indicated in the design drawings (e.g. for vapor barriers, etc...)** meeting the following gradation requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
3/4-inch	100
No. 4	80-100
No. 10	30-50
No. 40	10-30
No. 200	7-15

4. Granular Backfill: Crushed rock and sand well graded and readily compacted, non-plastic, meeting the following gradation requirements.

<u>Sieve Size</u>	<u>Percentage Passing</u>
1-inch	100
No. 40	15-60
No. 200	0-15

5. Base Course: CALTRANS Class 2AB, used for road grading may also be used for structural/engineered feel.

G. Bedding Course:

1. Pipe bedding material shall be a graded granular material.

<u>Sieve Size</u>	<u>Percentage Passing</u>
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 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:

<u>Sieve Size</u>	<u>Percentage Passing</u>
1-1/2-inch	100
3/4-inch	90-100
3/8-inch	40-100
No. 4	5-40
No. 8	0-5

I. Crusher Fines:

1. For use on pathways, trails, walkways, and other pedestrian-only areas for trail grading with a maximum particle size of 3/8". Minimum thickness is 6" unless noted otherwise in the design drawings. The gradation shall have the following requirements:

<u>Sieve Size</u>	<u>Percentage Passing</u>
3/8-inch	100
No. 4	90-100
No. 8	55-80
No. 16	40-70
No. 30	25-50
No. 200	6-15

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. Prepare for storm water pollution prevention per the plan and local requirements (reference SWPPP).
- 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 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

3.4 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 CONCRETE STRUCTURES

- a. Structures with foundations/floors that require excavation into bedrock excavation (if encountered at the site) and backfill requirements are summarized as follows:

Over-excavate 24 inches below bottom of foundation/slab into bedrock and recompact overex material in lifts no more than 6-inches thick, compacted to at least 90% relative compaction (as required in the Geotechnical report). Above the prepared subgrade and overex, place backfill and fill materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. Provide structural backfill back to bottom of foundation/structure, compacted to at least 90% of ASTM D1557 maximum density and moisture conditioned to +/-2% of optimum moisture. **Refer to the geotechnical report for additional details including estimated depths to bedrock.**

- b. Structures with foundation elevations above bedrock that require excavation to competent bedrock. This is not anticipated as required for this project, but if conditions arise where this becomes necessary, the following requirements are in place:

Excavate down to competent bedrock, then over-excavate 24 inches below bottom of foundation/slab into bedrock and recompact overex material in lifts no more than 6-inches thick, compacted to at least 90% relative compaction (as required in the Geotechnical report). Place backfill and fill materials above the compacted overex material in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose

depth for material compacted by hand-operated tampers. Provide structural backfill back to bottom of foundation/structure, compacted to at least 90% of ASTM D1557 maximum density and moisture conditioned to +/-2% of optimum moisture. **Refer to the geotechnical report for additional details including estimated depths to bedrock.**

- c. Structures with foundations not in bedrock and areas with minimal anticipated compaction from underlying bay mud including the **TWAS Awning/Enclosure and Sludge Storage basin structures:**

The existing surface soil within the structure pad areas should be removed to at least 24 inches below the lowest foundation grade and replaced with structural fill. The exposed sub-grade should be scarified to a depth of 8 inches, uniformly moisture conditioned to +/-2% of optimum moisture, and re-compacted to at least 90% of ASTM D1557 maximum density. Recompact scarified material in lifts no greater than 6-inches thick. Place backfill and fill materials above the scarified sub-grade in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. Provide structural backfill back to bottom of foundation/structure, compacted to at least 90% of ASTM D1557 maximum density and moisture conditioned to +/-2% of optimum moisture. **Refer to the geotechnical report for additional details including estimated depths to bedrock.**

- d. For concrete structures not otherwise specified above:

Concrete Structure Preparation (for structures less than 10 feet deep below existing grade) not otherwise specified above – The existing surface soil within the structure pad areas should be removed to 24 inches below the lowest foundation grade. The exposed sub-grade should be scarified to a depth of 8 inches, uniformly moisture conditioned to +/-2% of optimum moisture, and re-compacted to at least 90% of ASTM D1557 maximum density.

Concrete Structure Preparation (for structures deeper than 10 feet deep below existing grade) – The existing surface soil within the structure pad areas should be removed to the lowest foundation grade. The exposed sub-grade should be scarified to a depth of 18 inches, uniformly moisture conditioned to +/-2% of optimum moisture, and re-compacted to at least 90% of ASTM D1557 maximum density.

- e. **Provide vapor barrier beneath building/foundation floor slabs** (as indicated in the design drawings) for floor slabs/structures that will not contain water or liquid.
- f. For excavations into bedrock, the full 24” over excavation is not required. If excavation reached “competent” bedrock, the subgrade shall be over excavated a minimum of 6” then backfilled with 6” of Caltrans Class 2 Aggregate Base compacted to 90% relative compaction.
- g. In areas where excavation encounters soft bay mud, the subgrade shall be stabilized. The stabilization shall be implemented by a minimum 18” over

excavation and placement of a layer of biaxial Tensar geogrid over filter fabric. The over excavated area should then be backfilled with 18" Caltrans Class 2.

2. EXCAVATION FOR AUXILIARY STRUCTURE FOUNDATIONS:

- a. Auxiliary structures such as free standing or retaining walls shall have the existing soil beneath the structure foundation prepared in the manner recommended for the building pad except the preparation shall extend to 24 inches below and beyond the footing. Scarify the sub-grade and provide structural backfill for the 24-inch overex depth as described in paragraph 1.e above.
- 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 unsatisfactory native material and all satisfactory native excess material excavated. At Owner's discretion, remaining suitable overex material may be placed permanently on site rather than disposed of offsite.
- 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 just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.
- B. To mitigate potential settling along certain segments of new roadways, excavated material from this project shall be placed to pre-load/surcharge segments of the new roadway as indicated in the STAGING PLANS provided in the design drawings. Note that this material need not be suitable aggregate fill for pre-loading, as long as this fill is eventually removed and replaced with acceptable fill to the depths required for roadways. Surcharge loads should be placed to match the proposed final elevation along the roadway.

3.6 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 than 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 this 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 6 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.

3.7 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.

3.8 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.
 - 2. Several portions of this project require or highly recommend surcharging (e.g. the UV Building and segments of the new roadway). Accordingly, it is anticipated that stockpiles will be placed in these areas as either surcharge loads (or permanent backfill placed in advance to allow for settling) as they become available. Refer to the areas and elevations indicated in the design drawings and the Geotech report for additional details.

3.9 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. 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.
- E. Place and compact final backfill as required in the Specifications to final subgrade elevation.
 - F. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.
 - G. 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.
 - H. Pipe zone including bedding compaction requirements shall be ninety-five percent (95%) of maximum density (ASTM D 1557).
 - I. 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.
 - J. Aggregate base course materials shall be placed and compacted to not less than ninety-five percent (95%) of maximum density.

3.10 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 layers to required elevations using satisfactory native material or approved imported fill material.

3.11 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.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS UNDER STRUCTURES

- A. Place backfill and fill soil materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. **If meeting required compaction is an issue during verification of compaction, the Engineer may require placement of lifts in heights of 8 inches or 6 inches to ensure proper placement.**
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the percentages of maximum dry unit weight shown in section 3.4 and according to ASTM D 1557 and in accordance with Geotechnical report requirements and recommendations.
- 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.

3.13 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.

3.14 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.

3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE AND BUILDING SLABS

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 1. Place drainage 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.
 2. Compact each layer of drainage course by rolling it multiple times with a vibratory compactor. Final compaction to be inspected by the engineer prior to commencement of work.
- C. A sheet vapor retarder shall be installed at mid height of the drainage course.

3.16 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.

3.17 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.

3.18 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.

3.19 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

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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

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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.
 - 2. Where shoring occurs near and could impact existing structures, basins, footings, vibration limits for pile driving shall be established and monitored during shoring installation. Where vibration limits may be exceeded, drilled shafts or hydraulic jacks may be incorporated. Alternative pile methods shall be discussed with and approved by Owner and Engineer and submitted with technical submittal for shoring systems.
 - a. General vibration limits for adjacent structures consisting of reinforced concrete are as follows:

<u>Frequency:</u>	<u>Particle Velocity Limit (mm/s)</u>
<10 Hz	20 mm/s (0.8-inch/s)
10-50 Hz	40 mm/s (1.6-inch/s)
500-100 Hz	50 mm/s (2 inch/s)

- 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 319000 – GEOTECHNICAL REPORT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes three (3) reports summarizing different geotechnical investigations that were conducted at the site. The three reports are:
1. Main geotechnical investigation by DAC Associates, Inc. including design recommendations and criteria for this project (see attached 74-page report). **Dated July 23, 2018**
 2. Supplemental geotechnical investigation by DAC Associates Inc. specific to design recommendations and conditions in the area of the proposed sludge storage basin structure – see attached 14-page supplemental report. **Dated July 6, 2022**
 3. Geotechnical study of the stockpile material stored adjacent to Miller Creek conducted by Miller Pacific Engineering Group (MPEG) – see attached 25-page report. **Dated July 17, 2018**
 4. Geotechnical study of the sludge/fill material in the sludge storage ponds that is to be removed to facilitate installation of the new anoxic/aeration basins. This report was also conducted by Miller Pacific Engineering Group (MPEG) – see attached 22-page report. **Dated July 17, 2018**

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Updated Geotechnical Investigation Report
Secondary Treatment Upgrades Project
Las Gallinas Valley Sanitary District (LGVSD)
300 Smith Ranch Road, San Rafael, CA 94903

DAC Project No. 887-0715G

Prepared for

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July 23, 2018



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DAC Associates, Inc.
*Updated Geotechnical Investigation Report
LGVSD Secondary Treatment Upgrades
300 Smith Ranch Road, San Rafael, CA*

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- Appendix F — Strength-based Analysis of Drilled Pier Capacity



DAC Associates, Inc.
*Updated Geotechnical Investigation Report
LGVSD Secondary Treatment Upgrades
300 Smith Ranch Road, San Rafael, CA*

INTRODUCTION

As requested, we have performed a geotechnical investigation and developed geotechnical design parameters for the proposed secondary treatment upgrades project at the wastewater treatment facility belonging to Las Gallinas Valley Sanitary District. This document is the updated version of our October 11, 2017, geotechnical investigation report. Since then, the overall project layout has been modified and some components have been eliminated and some new ones introduced. In addition, locations of the proposed aeration and anoxic basins have been changed and, therefore, we performed supplemental exploratory borings in the proximity of the sludge ponds located to the southeast of the plant. This report presents the results from our review of available pertinent geologic and seismic hazard information and from our field investigation and engineering analysis. The soil and foundation conditions are discussed, and recommendations for the soil and foundation engineering aspects of the project are presented. Conclusions and recommendations contained herein are based on applicable standards of our profession at the time this report was prepared. Copies of this report are furnished only to provide the factual data that were gathered and summarized.

Site Location and Description

The Las Gallinas Valley wastewater treatment facility is located at 300 Smith Ranch Road, San Rafael, California. The facility is located in an area of Marin County, California, about 1 mile east of U.S. Route 101 and about 1 mile west of San Pablo Bay. The vicinity map in Figure 1 shows the location relative to these and other features.

The site of the upgrades project includes three areas of the facility: the main central facility area, the equalization basins, and the scrapyard. The coordinates of the project site are latitude 38.0244 to 38.0255 north and longitude -122.5175 to -122.5186 west. This area is irregularly shaped and measures roughly 650 ft across. It is bounded by Smith Ranch Road on the north, Miller Creek on the east, and land owned by others on the south and west.

Project Description

According to a drawing for the project titled *General Grading Plan*, dated April 20, 2018, (Figure 2), prepared by Aqua Engineering, the primary elements requiring geotechnical



input are (1) aeration and anoxic basins, (2) a primary pump station, (3) an electrical building, (4) two secondary clarifiers, (5) a mechanical thickeners unit, (6) a recycled water distribution pump structure, (7) a dechlorination dosing facility, (8) a UV building (alternative bid), (9) a water storage meter vault (alternative bid), and (10) raising of grade by placement of about up to 5 ft of fill. The pump station will have floor elevations of approximately -2.5 and 2.5 ft relative to mean sea level (msl), the anoxic and aeration basins will have floor elevations of approximately 4 to 9.5 ft amsl, the other structures will probably be built at grade, and the roadway grading will raise grade from about 10 ft to about 12–17 ft amsl. Figure 2, site plan, shows the locations of proposed facilities and our exploratory borings.

Purpose and Scope of Work

The purpose of our geotechnical investigation was to estimate overall characteristics of the soils underlying the site and to provide geotechnical recommendations for the proposed secondary treatment upgrade project. Our scope of work was as follows:

1. Locating underground utilities at the locations of the borings (task 4, below), which was based on a review of existing information provided by LGVSD and the services of a private underground utility locator. In addition, USA (Underground Service Alert) was notified regarding our proposed drilling locations.
2. Obtaining drilling permits from the Marin County Department of Environmental Health Services. As part of this process, an inspector from the department visited the site and observed our drilling and backfilling operation (task 4, below).
3. Reviewing published and unpublished geologic/geotechnical literature relevant to the site and project, which included several older geotechnical borings near certain elements of the project.
4. Drilling, logging, and sampling ten 6-inch-diameter exploratory borings to depths of 5½ to 50½ ft below the ground surface (bgs). All borings extended into bedrock. The borings were backfilled with grout or bentonite depending on the depth and presence of groundwater. These borings are designated BG-4 through BG-13; their locations are shown in Figure 2, and their logs are presented in Appendix A.



5. Collecting samples at 5-ft intervals in the borings by driving a split-spoon sampler or a modified California sampler. The former was generally used to collect disturbed samples of the surficial fill (granular soil) and bedrock, which were placed in Ziploc baggies. The latter was generally used to collect relatively undisturbed samples of the native soil (bay mud and colluvium) in stainless-steel tubes. HQ rock coring was performed in the rock in Boring BG-11. The samples were transported to our laboratory for classification and analysis of selected representative samples.
6. Characterization of the bedrock (e.g., rock type, structural features, hardness) primarily based on cut exposures at the site and secondarily based on samples retrieved from the bottoms of the borings. These observations were used to develop conclusions regarding conditions that will be encountered during excavation for certain project components.
7. Laboratory analysis of selected representative samples obtained from the borings. These included tests for moisture and density, percent passing the #200 sieve, unconfined compression, and consolidation. The results are presented on the boring logs in Appendix A and on the data sheets in Appendix B.
8. Geotechnical engineering analysis and evaluation of the field and laboratory test data; include contouring of the top of bedrock across the site.
9. Develop geotechnical conclusions and recommendations, including those for earthwork, foundations, walkways, pavements, and seismic design.

This report has been prepared in accordance with generally accepted geotechnical engineering practices, and with our agreement with Aqua Engineering for the exclusive use of their consultants for specific application to the secondary treatment upgrades project. In the event there are any changes in the ownership, nature, design or location of the proposed project, the conclusions and recommendations contained in this report shall not be considered valid unless (1) the project changes are reviewed by our office and (2) the conclusions and recommendations presented in this report are modified or verified in writing.

Reliance on this report by others must be at their own risk unless we are consulted on its use or limitations. This study is purely a geotechnical investigation and it does not include any environmental examination or evaluation of the surface and/or subsurface conditions.



We cannot be responsible for impacts of any changes in engineering and environmental standards, practices, or regulations subsequent to performance of services without our further consultation. We can neither vouch for the accuracy of information supplied by others nor accept consequences for unconsulted use of segregated portions of this report.

PREVIOUS WORK

In 2011, DAC Associates performed an investigation for an earlier recycled water facility project. A very short distance northeast of the site of the present project, three borings were drilled, logged, and sampled to depths of 12½ to 29 ft bgs. The boring locations are shown in Figure 2, and the logs are included in Appendix D.

In 2015, DAC Associates presented an investigation for improvements to the reclamation parking lot and roadway approach. Two borings were drilled, logged, and sampled to depths of 30½ and 31½ ft bgs a short distance northeast of the site of the present project. The logs are included in Appendix E.

The subsurface data from this previous work have been incorporated in the Findings, below, although priority and emphasis are given to the 2016 and 2018 findings from the present investigation.

FINDINGS

Surface Conditions

During the drilling on June 22 and 23, 2016, and March 26 and 27, 2018, we performed reconnaissance of the project site to observe general site conditions.

The site is generally level, with elevations ranging from approximately 10 to 11½ ft above mean sea level (amsl). There are unpaved and paved surfaces. There is a hill on the west side of the site. Its lower 20 ft exposes bedrock, evidently due to cutting as part of the original grading for the treatment facility several decades ago. The location of the proposed anoxic and aeration basins is presently an equalization basin that was created by a ring embankment. The basin consists of two shallow ponds, and the embankment supports a dense growth of trees and brush. The floor of the basin is at an elevation of about 3 ft amsl, and the crest of the ring embankment is at about elev. 10 ft amsl.



Subsurface Materials

Subsurface materials at the site, listed in downward succession, consist of fill, bay mud, colluvium, and bedrock. Due to cutting for the treatment facility several decades ago, bay mud and colluvium were not encountered in a few of the borings, whereas fill and bedrock were encountered in all the borings.

We encountered fill in all the borings to depths of 1½ ft bgs to 13 ft bgs. This layer is generally thicker nearer the bay and thinner nearer the hill to the west. The fill generally consists of a brownish-gray, damp to moist clayey sand with gravel that ranges from loose to very dense.

In Borings BG-1 through BG-3, BG-7, and BG-10, located nearest the bay, we encountered bay mud to depths of 9 to 29 ft bgs. This bay mud generally consists of dark gray, wet, soft to very soft, silty clay. Certain zones contain a few percent organic matter primarily in the form of fine plant fragments and give off an odor of H₂S.

In ten of the thirteen borings, we encountered a 1½- to 6-ft-thick layer of colluvium underlying the bay mud and overlying the bedrock. This colluvium generally consists of brown, moist to wet, stiff to hard, gravelly clay to clayey gravel. Colluvium is soil that typically mantles bedrock slopes and forms from weathering, creep, and slopewash. The colluvium in Borings BG-1 through BG-3, BG-7, BG-10, and BG-11 represents native slope material on the order of 8,000 years old that was buried by the bay mud as postglacial sea levels rose. The colluvium in Borings BG-4, BG-9, BG-12, and BG-13 represents native slope material that was buried under fill during the grading for the original construction of the wastewater treatment facility several decades ago. Colluvium is absent at the three remaining borings, Borings BG-5, BG-6, and BG-8, due to cutting during the original grading for the sewage treatment plant.

We encountered bedrock in all the borings at depths ranging from 1½ to 34 ft bgs. This bedrock generally consists of sandstone and shale that is generally gray, dry, very soft to moderately hard, and very intensely fractured. Drilling or sampler refusal (or both) was experienced in the majority of the borings after penetrating ½ to a few feet into bedrock. Based on a published geologic map of the area by Rice et al. (2002), the bedrock below the site belongs to mélangé of the Franciscan Complex, which is of Cretaceous to Jurassic age. Figure 3 shows the relevant portion of this geologic map.



Bedrock is exposed at the ground surface in two locations: (1) in the lower portion of the cut slope on the west side of the site and (2) at Boring BG-6. This rock generally consists of sandstone and shale consistent with the rock encountered in the bottoms of the borings. A substantial fraction, roughly half, of the exposed rock is hard and only moderately to slightly fractured. Appendix C presents our rock exposure observations in detail.

The rock encountered in the borings varies greatly in terms of its fabric/discontinuities. For example, in Boring BG-12, the rock is intensely sheared to yield a flaky, friable rock that could be logged as dense to very dense sandy/gravelly soil; it includes scattered rock blocks a few inches across. Less sheared, more rock-like, closely fractured, moderately soft to hard rock was encountered in Borings BG-7 and BG-13. The rock in Boring BG-11 was more intact such that coring was useful for obtaining several feet of penetration. The 7½ ft of coring from 43 to 50½ ft bgs yielded RQDs of 60% to 100% and intact pieces of rock up to 9½ in. long; rock that was of lower quality or was highly weathered to soil was encountered in Boring BG-11 between 34 and 43 ft bgs.

The variation in rock quality from one location to the next is typical of the Franciscan Complex. The intensely sheared material is typical of what geologists often map as a shear zone subunit of the Franciscan Complex.

Groundwater

The method of drilling and the timing and sealing of the borings did not allow for measurement of true, equilibrated levels of groundwater in the borings. However, conclusions can be drawn from the following observations. Groundwater was measured at depths of 8 and 4½ ft bgs in Borings BG-1 and BG-3. Boring BG-4, which extended to a depth of 13½ ft bgs, was left open for 24 hours, during which no free groundwater accumulated. Borings BG-5, BG-6, BG-8, which extended no deeper than 7 ft bgs, encountered no wet material or groundwater. Borings BG-7 and BG-10 did not accumulate free groundwater at the time of drilling, but the soil below depths of 8 and 10 ft bgs, respectively, was logged as wet, i.e., saturated. In Boring BG-9, free groundwater was measured at a depth of 6½ ft bgs immediately after drilling; this level is a few feet shallower than might be expected, which might be due to the unusual sand lens present between depths of 4½ and 6 ft bgs. These findings and general conditions in the vicinity of the site suggest that groundwater may be assumed to be at approximately sea level.



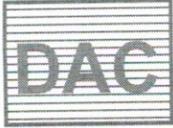
Fluctuations and deviations in groundwater elevations will occur locally and on seasonal and multi-year time scales due to variations in rainfall and surface and subsurface conditions.

Bedrock Surface Contours and Outcrop Pattern

We contoured the top of bedrock across the site, as shown in Figure 4. This contouring is based on the findings from the ten borings from this investigation and the five earlier borings by DAC Associates (2011, 2015), on the topography of the hill west of the site, on the rock exposure observations, and on interpolation and judgment. The elevations shown in Figure 4 are expressed in feet relative to sea level.

The hill west of the site is elongated northeast–southwest. Its rounded ridgecrest plunges to the northeast in the immediate vicinity. The subsurface data indicate that the bedrock contours where below sea level, i.e., buried under bay mud, are consistent with the exposed topography of the hill. The ridgecrest originally trended northeast through the footprint of the existing secondary biofilter and lies buried below fill and bay mud below the scrapyard. Southeast of this line, the top of bedrock slopes to the east, and northwest of the line, it slopes to the north and northwest. Due to cutting as part of grading for the site several decades ago, bedrock lies essentially at the ground surface south and west of a curve that passes through the existing primary and secondary biofilters, secondary clarifier #1, and fixed-film reactor, as shown in Figure 4.

Relatively hard and widely fractured sandstone was observed in Exposures 2, 4, and 5, and very high blow counts were noted in Borings BG-5, BG-6, and BG-8, which lie in the vicinity. Bedding that strikes northeast and dips southwest was measured in Exposure 3 and possibly in Exposure 2. Based on these findings, a southwest-dipping slab of resistant bedrock may pass northeastward through the site. The trace of this slab straddles the ridgecrest; in fact, the resistant bedrock is likely responsible for the presence and orientation of the ridgecrest. Several caveats should be kept in mind, however: The Franciscan Complex is notoriously contorted and variable, hence the *Complex* part of its name. The resistant rock slab itself is variable in that it contains soft shale beds, and the surrounding rock contains hard sand zones, both where they were identified in borings and potentially elsewhere.



Seismicity

The Rodgers Creek fault is located 6.5 miles northeast of the site, and the San Andreas fault is located 12 miles southwest of the site. Both of these faults are active and pose a high risk of strong ground shaking at the site. Figure 5 shows the locations of these and other faults relative to the project site. It should be assumed the site will probably be subjected to at least one moderate to severe earthquake that will cause strong ground shaking during the design life of the facilities.

CONCLUSIONS AND RECOMMENDATIONS

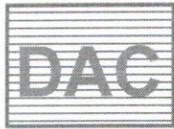
Based on the results of our geotechnical study, it is our opinion that the proposed project is feasible from a geotechnical engineering standpoint. However, the conclusions and recommendations presented in this report should be incorporated in the design of the project to help minimize potential future soil and/or foundation related problems.

The three primary geotechnical considerations to take into account in designing the proposed project are as follows:

- Compressible bay mud, which may potentially lead to total and differential settlements and potentially affect proposed facilities supported by fill and/or bay mud (e.g., the proposed raising of surface grades and roadway construction) and underground utilities under the site.
- Variable rock excavatability.
- Potential high ground accelerations during seismic events on the Hayward-Rodgers Creek fault system, San Andreas fault, and other active regional faults.

Geotechnical recommendations that incorporate these important considerations and other design considerations are provided in detail below.

Based on the results of our geotechnical investigation, the proposed project area within the overall site parcel is underlain by up to 25 feet of soft, compressible bay mud. The proposed new surface grades will be raised up to about 5 feet above the existing elevations. Based on the information from the District (Figure 6), a surcharge program has been implemented in 1982 to consolidate the bay mud and reduce future settlements due to the site development.



However, the surcharge typically consisted of a 3-foot layer of fill over the peripheral access road starting from the entrance to the treatment facility and ending just southeast of the overflow parking area. In addition, surcharging was performed within the area currently accommodating the filtered water storage facility. No surcharging was documented to the south, where the proposed new secondary clarifiers #1, #2, as well as where the aeration and anoxic basins will be constructed.

Therefore, we anticipate considerable total and differential settlements as a result of raising grades by about 5 feet, especially south of the 1982 surcharge program. The anticipated magnitude of bay mud settlement under 5 feet of fill ranges from 6 to 18 inches.

The soils we encountered below the site generally have a low potential for liquefaction during strong seismic ground shaking. Native subsurface materials within the saturated zone generally consist of soils with a high clay content or bedrock, neither of which is potentially liquefiable. The surficial fill lies above the saturated zone and consists of medium dense gravel and clay, and consequently is also not potentially liquefiable. The sand encountered in the depth interval of 4½ to 6 ft bgs in Boring BG-9 appears to be potentially liquefiable if it were saturated; however, it appears to be very limited in lateral extent.

Settlement, Construction Phasing, and Related Considerations

Based on findings from our outermost borings (BG-10 and BG-11) and the amount of proposed design fill, we estimate an average of 1 foot of future total settlement across the proposed roadways in those outer areas. On addition, an overall differential settlement of about 6 inches should be considered within a radius of about 50 feet, in areas underlain by deep bay mud deposits.

Therefore, we recommend placing the grading engineered fill early in the construction of the project and performing periodical settlement monitoring. After a certain amount of settlement has been observed, the foundation piers (next section) should be installed and **the basins constructed.**

The new fill will lower the factor of safety against slope instability along the east side of the proposed fill and roadway. The possibility of pavement cracking there will need to be assumed, particularly during seismic events along active faults in the region.



Earthwork and Fill Placement

Earthwork operation should be observed by the geotechnical engineer. In addition, any structural fill should be examined and approved by the geotechnical engineer in writing before application.

Before new design fill is placed, the uppermost 18 inches (minimum) of soil should be overexcavated and recompacted. The overexcavated material should be placed in lifts no more than 6 inches thick and recompacted to a minimum of 90% relative compaction.

If the new design fill consists of future dredging spoils, these materials will have a very high moisture content and will need to be spread and dried to a (lower) moisture content at which they may be used as fill. The moisture content may need to fall from roughly 120% to 20%, which may require several weeks to months, depending on the spread thickness and the weather.

Design fill should be placed in lifts no more than 12 inches thick and compacted to a minimum of 90% relative compaction at a few percent over optimum moisture.

Relative compaction refers to the in-place dry density of soil expressed as a percentage of maximum dry density of the same soil, as determined by ASTM Test Method D1557, latest version.

Surcharging

We recommend surcharging the southern portion of the plant, which was not included in 1982 surcharge program. This is especially important because raising finish grades in the subject area would potentially lead to large total and differential settlements. Such magnitudes of settlements could be detrimental to the structures supported on shallow foundations, buried structures, and utility lines.

Surcharging consists of subjecting compressible soils to loads larger than those intended for design of foundations or due to raising grades. The surcharge materials usually consist partially of soil that can be left in place after the surcharge period is complete and that part of the surcharge load that is removed. The final grades would then be underlain by less-compressible materials.



We recommend surcharging the area where the proposed UV/Bioassay building will be located. In addition, if feasible, we recommend surcharging the southern half of the east segment of the proposed new access road. This area starts from the limits of the 1982 surcharge program illustrated in Figure 6 of this report.

In order to reduce consolidation settlements below the proposed UV/Bioassay building, we recommend a surcharge program with a maximum surcharge load equivalent to a 15-foot layer of fill for a period of about 8 to 12 months. Even after performing such a surcharge program, we anticipate total and differential settlements of about 6 and 3 inches respectively to occur below the UV/Bioassay building.

The surcharge load should be added incrementally over an area 30 feet beyond the perimeter footprint of the building. Monitoring of settlement and porewater pressure should be performed in order to evaluate the rate of consolidation of bay mud and to evaluate allowable bearing capacity below the surcharge area. We recommend a monitoring program with frequent measurements beginning in the week following surcharge placement. The frequency of monitoring could be reduced as the rate of settlement decreases.

The surcharging program should be coordinated with the geotechnical engineer to determine the magnitude of consolidation settlement, type of material to be used for surcharging, method of placement and compaction, and to minimize potential bearing capacity failure due to surcharging activity.

Lightweight Fill

Where the bay mud is thick, partial excavation of the existing material and backfilling with lightweight material will help to balance the total imposed load. The amount of excavation depends on the unit weight of the material to be excavated and the unit weight of the lightweight fill to be used. The lighter the material, the less excavation would be required. Sometimes it is not possible to use lightweight fill to completely offset an additional imposed loads, however, it can reduce the additional load to a tolerable amount.

Lightweight fill materials commonly used by Caltrans are

- Expanded polystyrene (EPS), or Geofoam
- Cellular concrete (foamed concrete)
- Natural (volcanic) lightweight materials



- Expanded shale, wood fiber (saw dust), and shredded tires.

Use of shredded tires has been encouraged by the California Department of Resources Recycling and Recovery in their effort to reduce stockpiles of disposed tires. FHWA issued an interim guideline limiting the maximum thickness of shredded tire fill to 10 feet. Consider the following when selecting a lightweight fill:

- Availability of fill material
- Its engineering properties
- The durability, water absorption potential, corrosion potential, and other unique characteristics
- Design and construction considerations
- Cost for using lightweight fill versus conventional construction

The engineering properties of granular lightweight fill material to evaluate should include its density, the angle of shearing resistance, and cohesion. The properties of EPS and cellular concrete to evaluate should include its density and compressive strength. Table 1 provides a list of various lightweight materials and their ranges of densities and specific gravities.

Table 1 Lightweight materials and selected properties

Lightweight fill type	Range of densities (pcf)	Range of specific gravities
Natural (volcanic) material	50 to 75	0.80 to 1.2
Expanded polystyrene (EPS)	0.8 to 2	0.01 to 0.03
Cellular (foamed) concrete	20 to 61	0.3 to 0.8
Wood fiber (sawdust)	34 to 60	0.6 to 1.0
Shredded tires	37 to 56	0.6 to 0.9
Expanded shale	37 to 65	0.6 to 1.0
Fly ash	70 to 90	1.1 to 1.4
Boiler slag	62 to 109	1.0 to 1.8
Air-cooled slag	69 to 94	1.1 to 1.5



For more information regarding design parameters (density, angle of shear resistance, permeability and compressibility), environmental considerations, design consideration and construction consideration of granular lightweight fill such as wood fiber, air-cooled blast furnace, fly ash, boiler slag, expanded shale and shredded tires, refer to Tables 2 through 7 of FHWA NHI-06-019, dated August 2006.

Rock Excavatability

Some of the sandstone bedrock is hard and widely fractured and therefore may be relatively difficult to excavate. This relatively hard rock may be more prevalent in a band passing northeast through the existing secondary biofilter, but undoubtedly additional zones of hard rock are present due to the chaotic, difficult-to-predict nature of the Franciscan Complex bedrock. Before selecting excavation equipment, contractors should directly examine all the existing rock exposures at the site, including the locations shown in Appendix C, to develop their own assessments of rock excavatability. Contractors should also note that additional rock exposures and data regarding rock conditions will likely come to light after certain structures at the site are demolished as part of the project.

Shoring and Dewatering

Construction of facilities that require deep excavation, such as the pump station, would need to have proper shoring. The excavation shoring should be designed by an experienced professional engineer and reviewed by the project geotechnical engineer.

In addition, due to presence of relatively high groundwater (between 4 to 8 feet below existing ground surface), excavations to certain depths will experience groundwater inflow. The contractor should therefore incorporate provisions for general site dewatering in the construction procedures. However, dewatering may lead to some consolidation settlement of the bay mud, which in turn may result in settlement of existing foundations in the vicinity of the excavation area. It is therefore prudent to actively involve the geotechnical engineer in the process of excavation shoring and dewatering for the project.

The contractor shall bear the full responsibility of the design and construction of all excavation shoring and dewatering throughout the project.



Foundations and Retaining Walls

Shallow Foundation

Structures that will bear on competent bedrock, or on engineered fill over competent bedrock, should be designed with allowable bearing pressures of 2,000 pounds per square foot (psf) for dead loads, 3,000 psf for dead plus live loads, and 4,000 psf for all loads including wind and seismic. Resistance to lateral loads may be developed from friction between the bottoms of foundations and competent bedrock based on a friction coefficient of 0.35 and from passive resistance in competent bedrock equivalent to a fluid pressure of 450 pounds per cubic foot (pcf) acting against the vertical faces of foundations.

Structures that will have finished floors at approximately the ground surface, and are located within the limits of 1982 surcharge program or, where the depth to bedrock is less than 10 feet, may be supported on a mat foundation on prepared subgrade. The subgrade preparation should consist of overexcavating the existing underlying soil to a minimum depth of 24 inches and backfilling with Caltrans Class 2 aggregate base. Allowable bearing pressures in designing these mat foundations should be 500 psf for dead (sustained) loads, 750 for dead plus live loads, and 1,000 psf for all loads including wind and seismic. A friction coefficient of 0.3 should be used between the bottom of the foundation and subgrade soils for lateral load resistance. If additional resistance to lateral loads is required, a passive pressure, below 12 inches from ground surface, equivalent to a fluid pressure of 300 pcf acting against vertical face of foundations could also be considered. The estimated long-term total settlement of the mat foundation described above, under these recommended loads, is estimated at about 1 to 3 inches with ½ inch to 1½ inches of differential settlement across the building.

Facilities that will not be able to tolerate considerable settlement and whose finished floors would be underlain partly by bedrock and partly by soil, may be supported by a shallow foundation provided that the soil is removed and replaced with controlled low-strength material (CDF) and that some of the bedrock below design subgrade elevation is also overexcavated and replaced with CDF material. This material should conform to the requirements in Section 19 of the Caltrans Standard Specifications. The overexcavation of bedrock should extend to a minimum depth of 2 feet below subgrade elevation. The geotechnical design parameters for the foundations bearing on this material can be those recommended for competent bedrock given at the beginning of this section.



Passive pressure in the upper 1 ft of soil where the footings are not confined by a slab or pavement should be neglected. Foundation excavation bottoms should be kept moist until placement of concrete. Water should not be allowed to stand in construction excavations.

Drilled Pier/Caisson Foundation

Facilities that will not be able to tolerate considerable settlement and whose finished floors would be underlain entirely by soil, such as aeration and anoxic basins as well as the electrical building, should be provided with a foundation consisting of drilled piers/caissons. The drilled piers should derive their load-bearing capacity from skin friction and end bearing in competent bedrock.

The drilled piers should have a minimum diameter of 18 inches. In developing the design, an allowable skin friction of 1,000 psf in compression and 800 psf in tension should be used, and allowable end-bearing pressures of 2,000 psf for dead loads, 3,000 psf for dead plus live loads, and 4,000 psf for all loads including wind and seismic may also be included.

In designing the lateral load resistance, a passive pressure equivalent to 450 pcf in competent bedrock, applied to two pier diameters, should be used. If additional lateral load resistance is required, a passive soil pressure of 300 pcf, below 12 inches from ground surface, could be used to act against vertical faces of pile caps or grade beams, provided the top 24 inches of the surface soils adjoining the grade beams are reworked and compacted with a minimum 95 percent relative compaction.

We performed an alternative strength-based analysis for development of ultimate capacities of drilled pier foundation system for the aeration and anoxic basins, also applicable to the electrical building. This analysis was based on Geotechnical Axial Design Methodology For Colorado Drilled Shafts Socketed in Weak Rocks, and is presented in Appendix F of this report.

Retaining Structures

An active pressure equivalent to a fluid pressure of 45 pcf should be used in designing all retaining structures, assuming level backfill. This active pressure should be increased by 1 pcf for every two degrees of backfill slope. For restrained retaining structures, the above active pressure should be increased to an at-rest pressure by adding a uniform pressure of $11H$, where H is the height of backfill above the top of wall footing.



Buried structures should also be designed to resist full hydrostatic pressure (assuming groundwater level at surface grade about elevation +12.5') in addition to the above active earth pressures. Above-ground retaining walls should be fully backdrained or otherwise designed to resist the additional hydrostatic pressure.

In addition, pressure due to equipment used for backfill operation or other surcharge loads should also be considered in design of the retaining structures.

For retaining walls that will support more than 6 ft of backfill, a seismic load (PE) per unit length of the wall should be also be included in calculating the lateral load. This seismic load, which should be applied at 0.6 of the height (0.6H) above the base of the wall, should be calculated using the equation $PE = (3/8)\gamma H^2 k_h$, where PE is the lateral load due to seismic forces applied at 0.6H above base of the wall (lb), γ is the unit weight of the soil, which is 110 pcf, H is the height of the retained soil (ft), and $k_h = PGAM/g = 0.504$ which was obtained from ASCE 7-10, Figure 22-7 and Equation 11.8-1.

For determination of lateral load resistance of buried structures, a soil passive pressure equivalent to a fluid pressure of 300 pcf could be used acting against the vertical face of below grade retaining walls. In evaluation of passive resistance, the top one foot of soil should be ignored unless it is covered with a continuous slab or pavement. If the bottom of a buried structure is located on bedrock (or engineered fill underlain by bedrock), a friction coefficient of 0.3 could also be used between the bottom of the foundation and subgrade soils for lateral load resistance.

Concrete Walkways

Concrete walkways should be supported directly on the properly prepared and compacted engineered fill. Subgrade soil should be compacted to at least 90% relative compaction at a few percent above optimum moisture content to provide a smooth, unyielding surface. Subgrade soil should be maintained in a moist and compacted condition until covered with the concrete walkway section.

Pavement Sections

The following recommendations for preliminary asphalt concrete pavement sections are intended as a conceptual guide for planning only. Pavement analyses are based upon an



assumed resistance (R) value of 5, which we expect to be representative of final pavement subgrade materials, the Caltrans "Design Method for Flexible Pavement," and traffic indices (TIs), which are indications of load frequency and intensity. We assumed that assigned TIs will include provisions for heavy truck traffic related to construction activities. The table below presents our recommended preliminary pavement sections.

Table 2. Preliminary recommended A.C. pavement sections.

Traffic index	Thickness (inches)	
	Asphalt concrete, Type B	Aggregate base, Class 2
4.0	2.5	8.0
4.5	2.5	10.0
5.0	2.5	11.0
5.5	3.0	12.0
6.0	3.0	14.0
6.5	3.5	15.0
7.0	4.0	16.0

Class 2 aggregate base should conform to the requirements in Section 26 of Caltrans "Standard Specifications" (July 2002). The aggregate base should be placed in thin lifts in a manner to prevent segregation, uniformly moisture conditioned, and compacted to at least 95 percent relative compaction to provide a smooth, **unyielding** surface. (Relative compaction refers to the in-place dry density of soil expressed as a percentage of maximum dry density of the same soil, as determined by ASTM Test Method D1557-00.)

Seismic Design Parameters

We have developed site-specific spectral seismic design parameters based on Standard ASCE 7-10, which is based on U.S. Geological Survey hazard data available in 2008. These design parameters are for use by the structural engineer when addressing potential seismic shaking in designing the new buildings.



Because of the variations in subsurface conditions across the site and the various finished floor elevations of the proposed structures, the applicable site classes vary among Site Classes C, D, and E. The site classes may be thought of as being distributed in three concentric zones progressing outward from Classes C through E across the treatment plant site. A wide inner zone of Site Class C is present where the top of bedrock is exposed or is a few feet below the ground surface. A narrow (about 50 ft wide) band of Site Class D wraps around the Class C zone. A wide outer zone of Site Class E is present nearest to the bay, where bedrock is deepest. However, the site class can vary at a specific location depending on the proposed finished floor elevation: excavating below grade for a structure brings bedrock higher relative to the finished floor elevation and thereby tends to affect the site class accordingly. Table 3, below, presents our findings and recommendations.

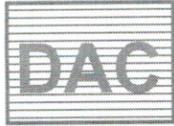
Table 3. Recommended seismic design parameters

Structure	Site characteristics			Seismic design parameters			
	Latitude	Longitude	Site class	S _{MS}	S _{M1}	S _{DS}	S _{D1}
Dechlor dosing facility	38.0252	-122.5178	D	1.500	0.900	1.000	0.600
Secondary clarifier #2	38.0250	-122.5184	C	1.500	0.780	1.000	0.520
Electrical building	38.0249	-122.5176	E	1.350	1.440	0.900	0.960
Secondary clarifier #1	38.0246	-122.5185	C	1.500	0.780	1.000	0.520
Primary pump station	38.0248	-122.5182	C	1.500	0.780	1.000	0.520
Anoxic and aerobic basins	38.0242	-122.5180	E	1.350	1.440	0.900	0.960
RWTF distribution pumps	38.0237	-122.5187	D	1.500	0.900	1.000	0.600

Additional Services

Additional geotechnical engineering services will be needed for design and construction of the project. These include plan review, and responses to plan-check comments, and construction observation by DAC Associates, Inc.

Our firm should be accorded the opportunity to review the final plans and specifications to determine if the recommendations of this report and our applicable earlier reports have been implemented in those documents. Results of the review should be summarized in writing.



DAC Associates, Inc.

*Updated Geotechnical Investigation Report
LGVSD Secondary Treatment Upgrades
300 Smith Ranch Road, San Rafael, CA*

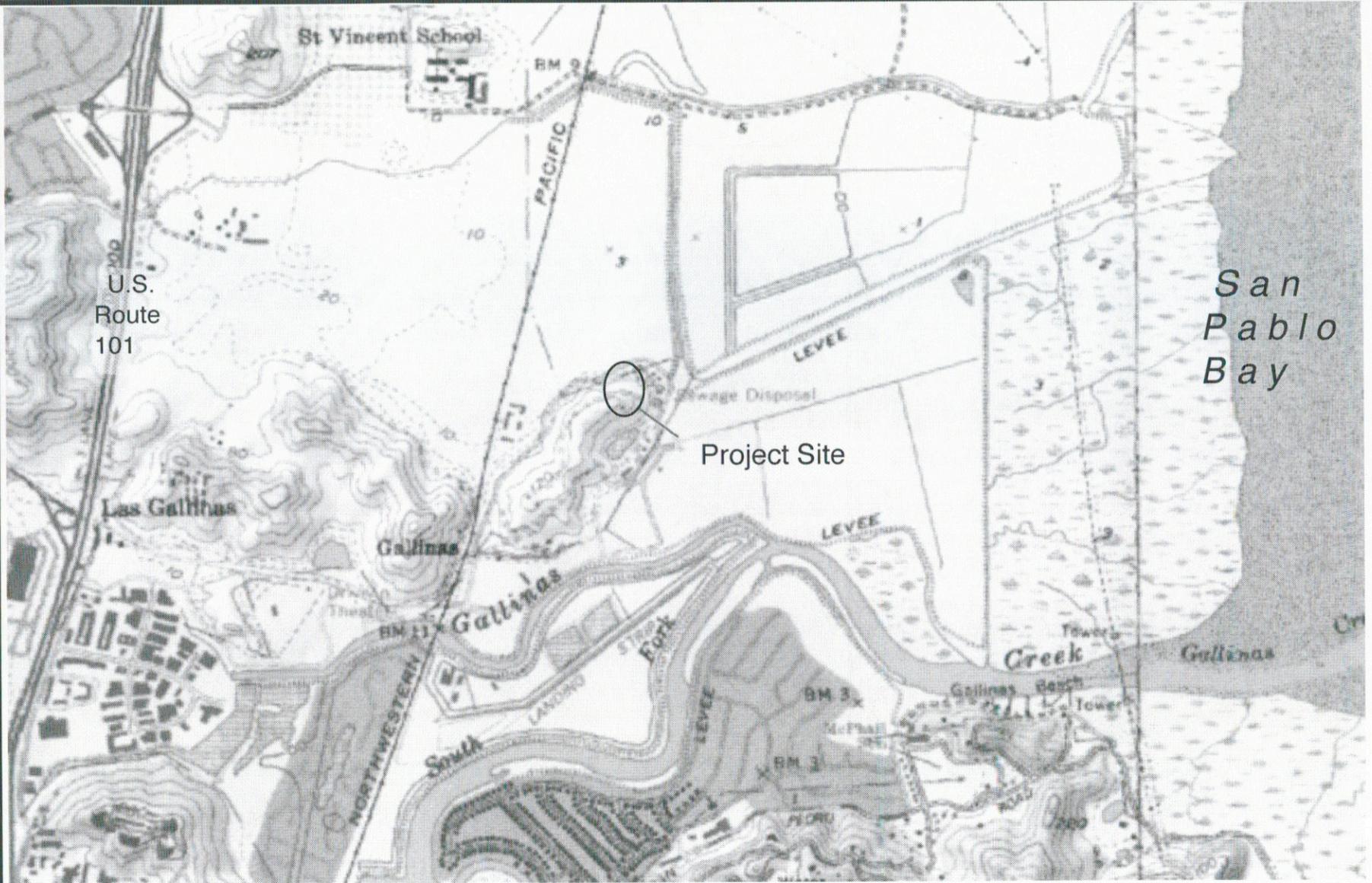
To a great degree, the performance of the site grading and improvement depend on construction procedures and quality. Therefore, we should provide on-site soil observations of the contractor's procedures and the exposed soil, together with field and laboratory testing during excavating for foundations, preparation of subgrade under walkway slabs, placement of foundations, and placement and compaction of fill. These observations will allow us to check the contractor's work for conformance with the intent of our recommendations and to observe any unanticipated soil conditions that could require modification of our recommendations. In addition, we would appreciate the opportunity to meet with the contractor before the start of grading to discuss the procedures and methods of construction. This can facilitate the performance of the construction operation and reduce possible misunderstandings and construction delays.



DAC Associates
*Updated Geotechnical Investigation Report
LGVSD Secondary Treatment Upgrades
300 Smith Ranch Road, San Rafael, CA*

References

- DAC Associates, Inc. 2011, Geotechnical investigation report, Las Gallinas Valley Sanitation District Recycled Water Facility project, 300 Smith Ranch Road, San Rafael, California: DAC Associates (San Rafael, California) report for project 568-1011G, prepared for Aqua Engineering Inc., Bountiful, Utah.
- DAC Associates, Inc. 2015, Geotechnical investigation report, Phase 1, Reclamation Parking Lot and Roadway Approach Improvements, Las Gallinas Valley Sanitation District, 300 Smith Ranch Road, San Rafael, California: DAC Associates (San Rafael, California) report for project 859-7714G, prepared for BKF Engineers, Redwood City, California.
- Rice, S.J., Strand, R.G., Smith, T.C., 1976, Geology of the eastern part of the San Rafael area, Marin County, California: U.S. Geological Survey Open-File Report OFR-7.



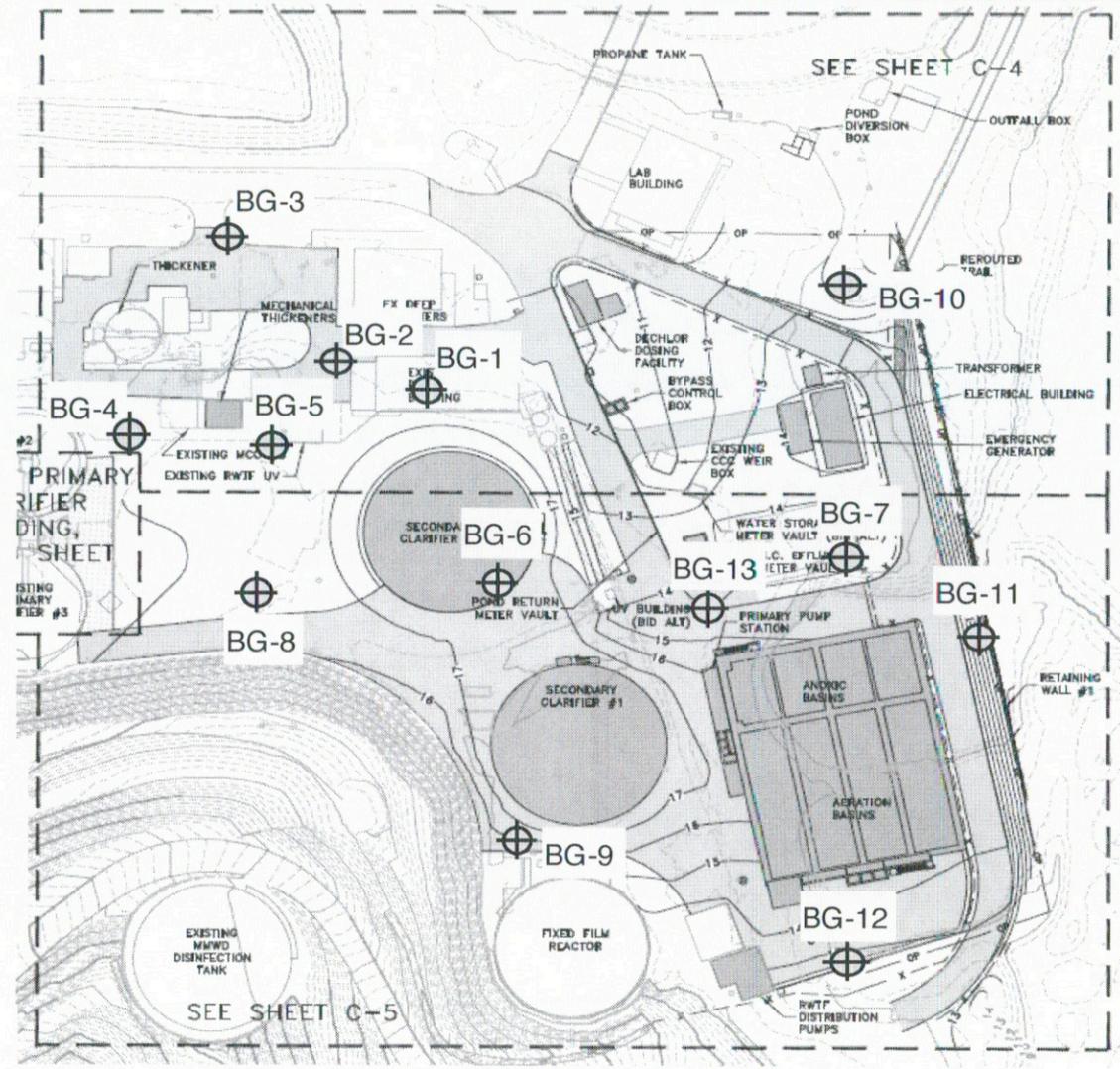
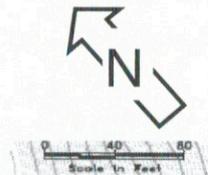
DAC101-2003



Vicinity Map
LGVSD Facility
300 Smith Ranch Road
San Rafael, CA

Report Date:	July 2018
Reviewed By:	DA
Proj. Manager:	DA
Job No.:	887-0715G

Figure 1



Key
 BG-13  Boring location

Borings BG-4 through 13 from this investigation.
 Borings BG-1 through 3 from DAC Associates

Project 887

Base: General Grading Plan by Aqua Engineering, dated April 20, 2018

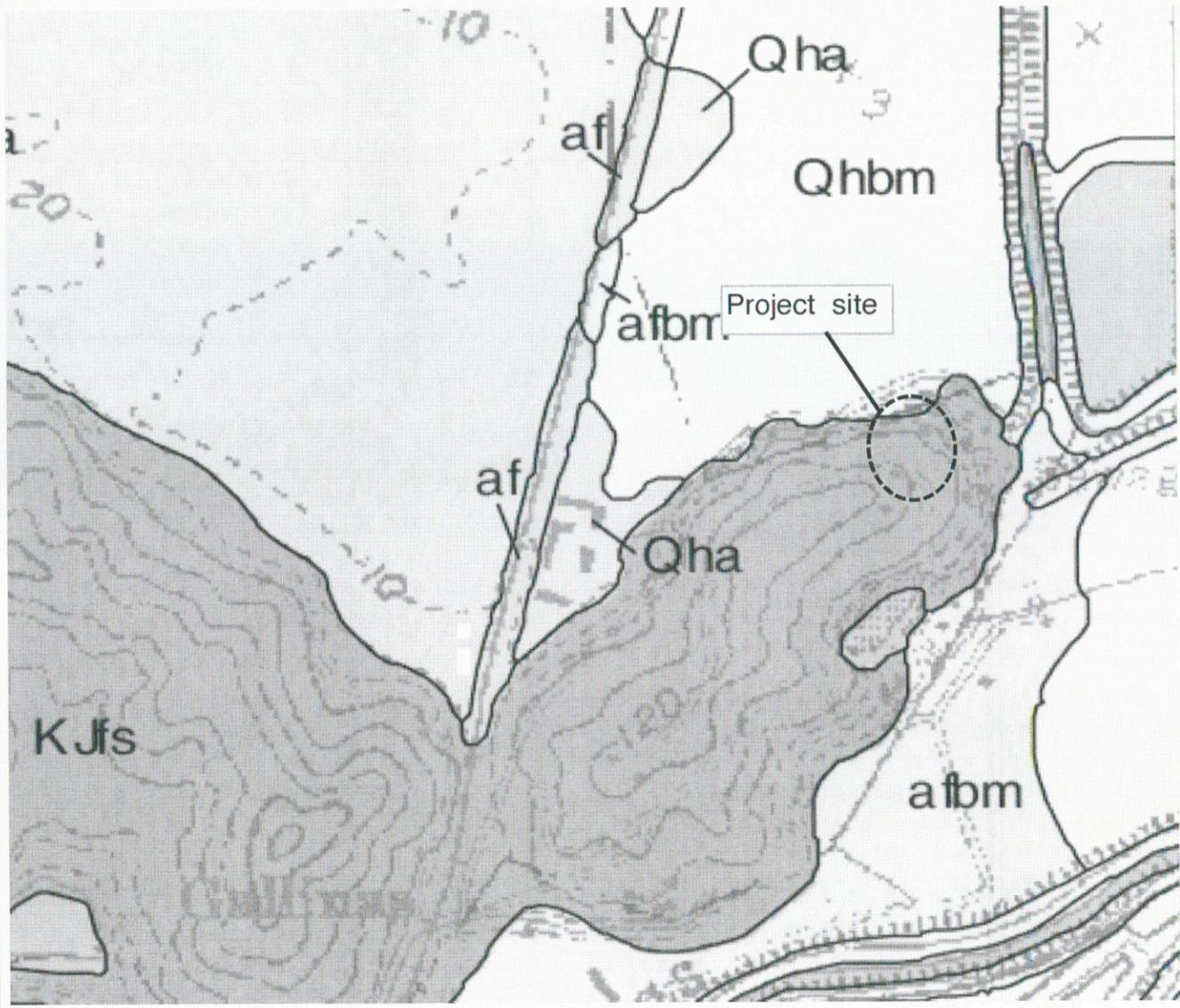
DAC101-2003



Site Plan
LGVSD Facility
300 Smith Ranch Road
San Rafael, CA

Report Date:	July 2018
Reviewed By:	DA
Proj. Manager:	DA
Job No.:	887-0715G

Figure 2



- afbm** artificial fill placed over bay mud
- Qhbm** estuarine deposits (bay mud)
- Qha** alluvium
- KJfs** Franciscan Complex sandstone and shale

Base: Rice et al. (2002)

DAC101-2003

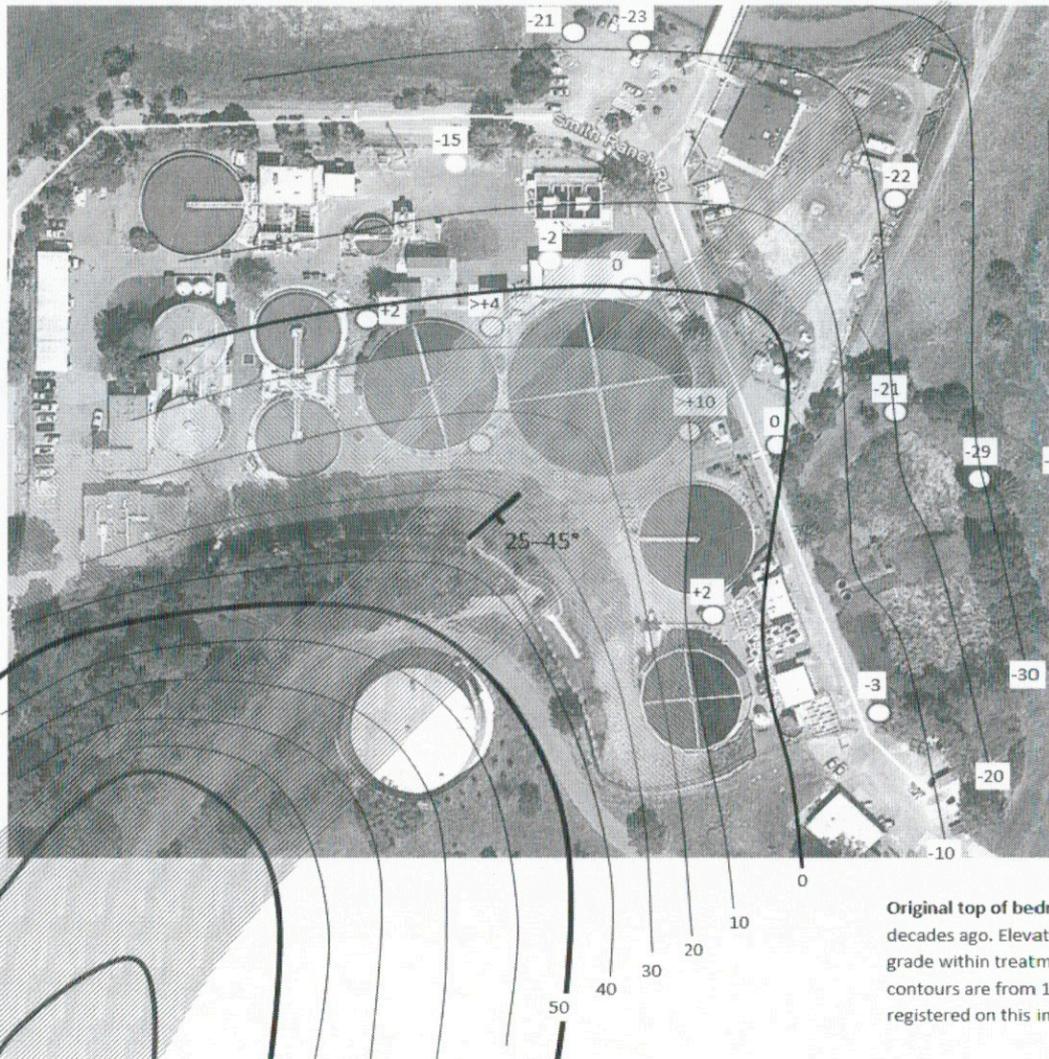


Regional Geologic Map

LGVSD Facility
300 Smith Ranch Road
San Rafael, CA

Report Date:	July 2018
Reviewed By:	DA
Proj. Manager:	DA
Job No.:	887-0715G

Figure 3



- Top-of-bedrock elev. at boring
- 22 This investigation
- 23 DAC Associates, 2015
- 15 DAC Associates, 2011
- Conjunctured resistant bed composed of hard sandstone with minor intercalated shale; location schematic, very approximate; additional similar zones likely present
- Zone of cut from grading for treatment plant — rock essentially at ground surface
- Bedding attitude 25-45°

Original top of bedrock, before mass grading for treatment plant several decades ago. Elevations are feet relative to mean sea level. Assumed grade within treatment facility is +10. The 50-, 100-, and 150-ft elevation contours are from 1942 U.S. Geological Survey topography crudely registered on this image.

Base: Google Earth image dated 4/1/2015

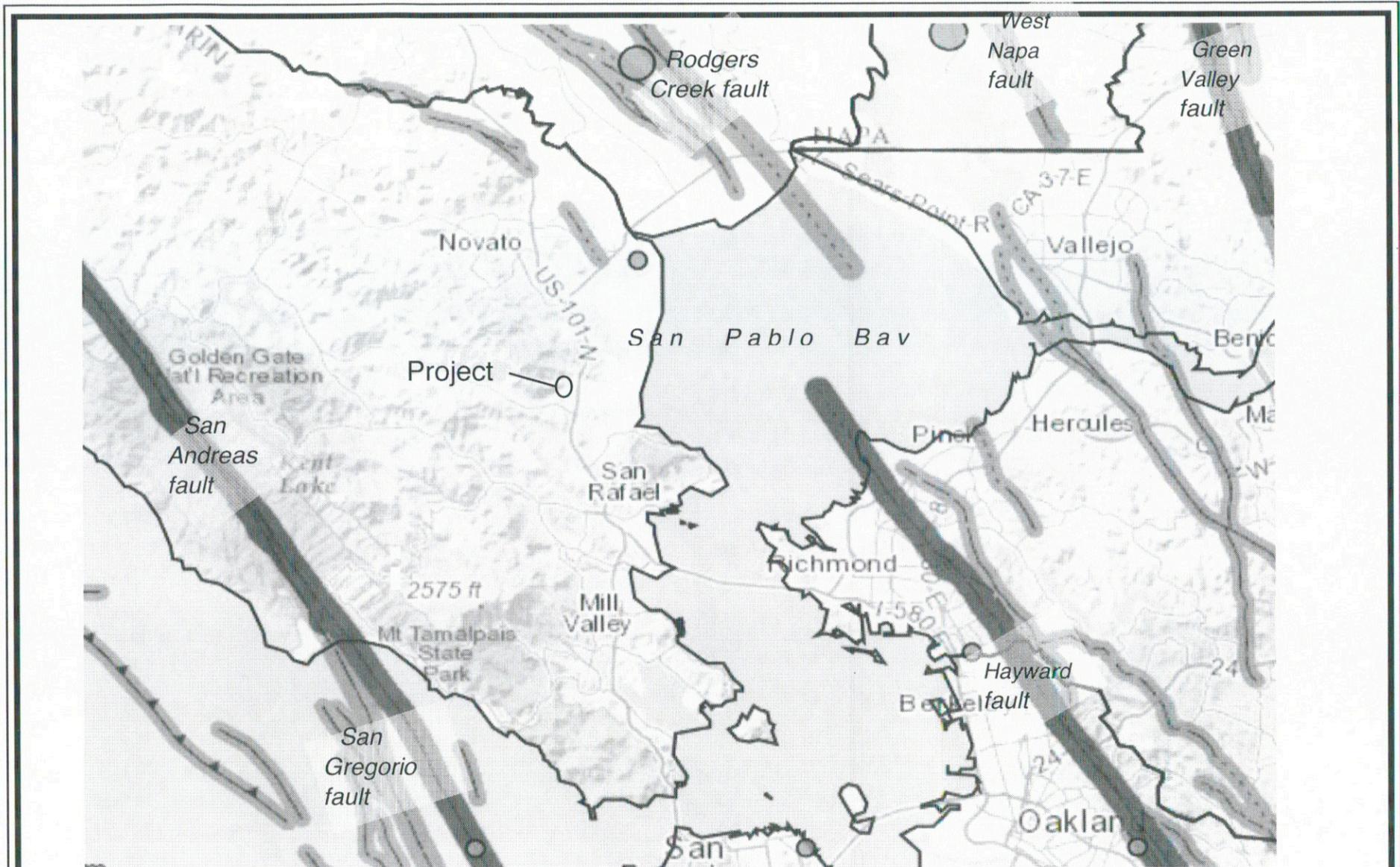
DAC101-2003



Bedrock Contours
LGVSD Facility
300 Smith Ranch Road
San Rafael, CA

Report Date:	July 2018
Reviewed By:	DA
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Job No.:	887-0715G

Figure 4



Source: California Geological Survey, <http://maps.conservation.ca.gov/cgs/historicearthquakes/>, accessed 2016

DAC101-2003

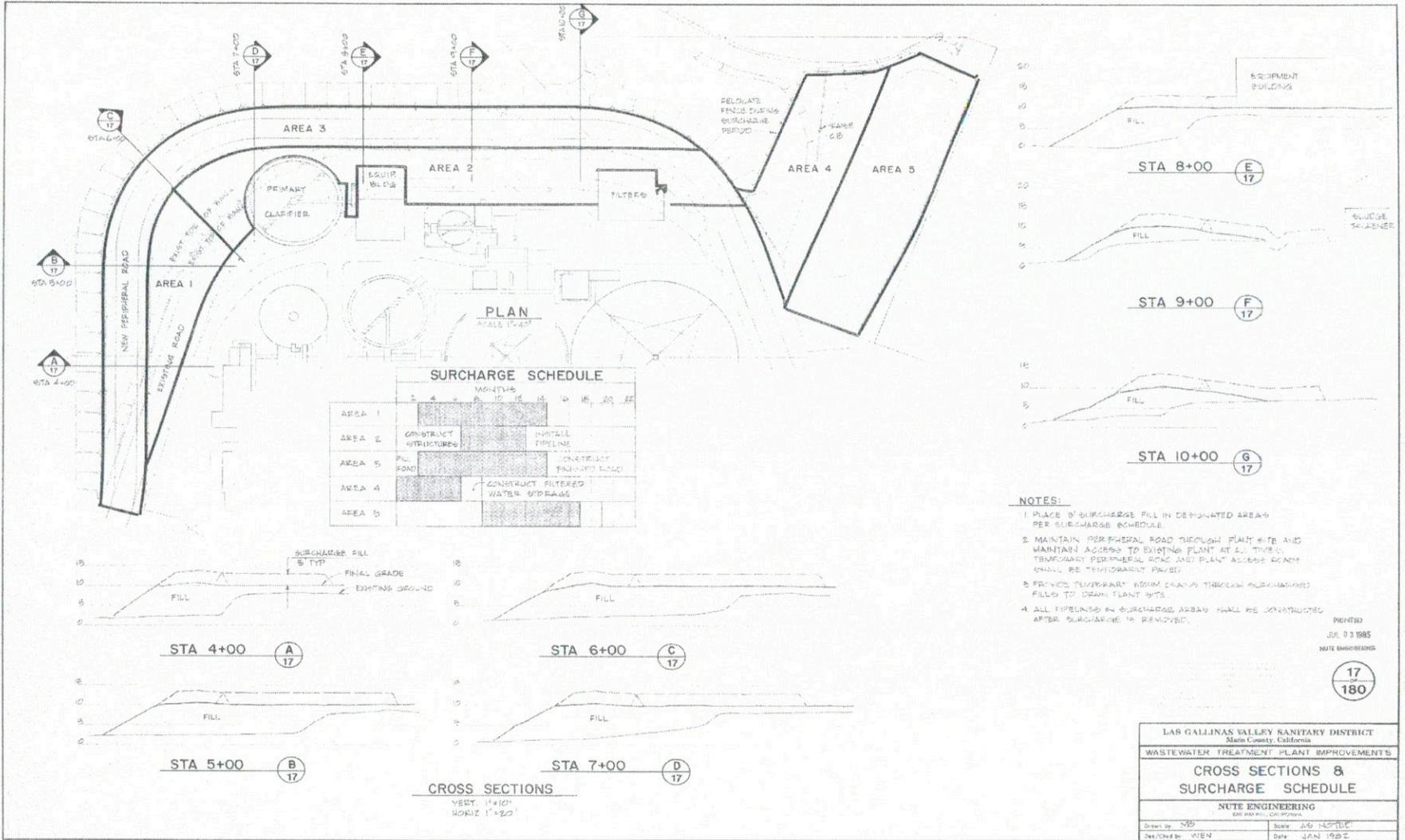


Regional Seismicity

LGVSD Facility
300 Smith Ranch Road
San Rafael, CA

Report Date:	July 2018
Reviewed By:	DA
Proj. Manager:	DA
Job No.:	887-0715G

Figure 5



1982 Surcharge Plan
LGVS D Facility
300 Smith Ranch Road
San Rafael, CA

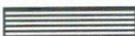
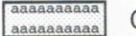
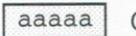
Report Date:	July 2018
Reviewed By:	DA
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Job No.:	887-0715G

Figure 6

Appendix A

Boring Logs

Material Symbols

 Topsoil  Fill  Asphalt  High-Plasticity Clay (CH)  Low-Plasticity Clay (CL)  Silt	 Loose Sand  Dense Sand  Gravel  Cobbles  Rock / Concrete  Colluvium
---	---

Sample Types

 Standard Penetration Test (SPT)  Modified California Sample (MC)	 Bulk Sample (Bag)  Shelby Tube Sample (Push)
--	--

Grain Sizes

	U.S. Standard Series Sieve				Clear Square Sieve Openings		
	200	40	10	4	3/4"	3"	12"
Silts and Clays	Sand			Gravel		Cobble	Boulder
	Fine	Medium	Coarse	Fine	Coarse		

Relative Density

Sands and Gravels	Blows/ Foot*
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

Consistency

Silts and Clays	Blows/Foot	Strength (tsf)**
Very Soft	0-2	0-1/4
Soft	2-4	1/4-1/2
Firm	4-8	1/2-1
Stiff	8-16	1-2
Very Stiff	16-32	2-4
Hard	Over 32	Over 4

* Number of blows for a 140-pound hammer falling 30 inches, driving a 2-inch O.D. (1-3/8" I.D.) split spoon sampler 12 inches into soil.

** Unconfined compressive strength.

Terminology & Abbreviations

W _n Natural Moisture Content	LL Liquid Limit	pp Pocket Penetrometer
γ _d Dry Density	PL Plastic Limit	C _u Undrained Shear Strength
O _c Organic Content	PI Plasticity Index	U _c Unconfined Compressive Strength



Key to Boring Log

LGVSD Secondary Treatment Upgrades
 300 Smith Ranch Road,
 San Rafael, CA

<u>Report Date:</u>	July 2018
<u>Reviewed By:</u>	DA
<u>Proj. Manager:</u>	DA
Job No. 887-0715G	

Figure A-0

Project 887-0715G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: June 22, 2016	Drill Rig: CME 75	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater: no free gw accumulated	Boring Log BG-4			Logged by FJG

	Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
1					CLAYEY SAND W GRAVEL (SC) — fill: grayish brown, damp, very dense, 35% fines, 15% gravel up to 1 in. diam.	1
2						2
3						3
4						4
5	SPT	5	$w_n = 12.5\%$		SANDY CLAY (CL) — colluvium: brownish gray, moist, stiff, 40% sand and angular gravel up to 1½ in. diam.	5
6		7				6
7					SHALE and SANDSTONE — KJfs: gray, moist, soft, sheared, weathered to clay, calcite nodules	7
8						8
9						9
10	SPT	9				difficult drilling at 12 ft
11		19			18	
12	SPT	27				12
13		23				27
14					Boring left open for 24 hrs and then backfilled with bentonite pellets.	14
15						15
16						16
17						17
18						18
19						19

DAI.132-E007

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-1
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Project 887-0715G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: June 22, 2016	Drill Rig: CME 75	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater: no free gw accumulated	Boring Log BG-5			Logged by FJG

	Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
1					P.G. GRAVEL W SILT AND SAND (GP-GM) — fill: brownish gray, dry, very dense, gravel is angular sandstone up to 1½ in. diam., 10% silt, 20% sand	1
2						2
3						3
4						4
5	SPT	7 30	w _n = 1.8%		difficult drilling at 6 ft	5
6		39			SANDSTONE — KJfs: brownish gray, damp, moderately soft, core-in-matrix texture, faint relict bedding and shearing, yellowish brown staining	6
7	SPT	50/4"				Boring backfilled with bentonite pellets immediately after drilling.
8						8
9						9
10						10
11						11
12						12
13						13
14						14
15						15
16						16
17						17
18						18
19						19

DAC132-2007

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-2
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Project 887-0715G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: June 22, 2016	Drill Rig: CME 75	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater: no free gw accumulated	Boring Log BG-6			Logged by FJG

	Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
1					P.G. GRAVEL W SILT AND SAND (GP-GM) -- fill: brownish gray, damp, very dense, gravel is angular sandstone up to 1½ in. diam., 10% silt, 20% sand	1
2	SPT	7			SANDSTONE -- KJfs: yellowish brown to gray, damp, very soft	2
3		8				3
4		13				4
5	SPT	25			yellowish brown	5
6		45				6
6		50/5½			Boring backfilled with bentonite pellets immediately after drilling.	6
7						7
8						8
9						9
10						10
11						11
12						12
13						13
14						14
15						15
16						16
17						17
18						18
19						19

DAC 132-2017

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-3
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

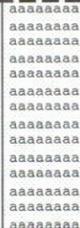
Project 887-0715G	LGVWT Facility, 300 Smith Ranch Road, San Rafael		Driller: Clear Heart
Date: June 23, 2016	Drill Rig: CME 75	Hollow-stem auger	Hammer: 140 pound
Groundwater: no free gw accumulated	Boring Log BG-7		Logged by FJG

Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
				P.G. GRAVEL W SILT AND SAND (GP-GM) -- fill: brownish gray, damp, medium dense	1
				alternating with layers of	
				SANDY CLAY (CL) -- fill: mottled, moist, stiff	2
					3
					4
SPT	7				5
	6				6
	6				6
					7
					8
				CLAYEY GRAVEL (GC) -- bay mud, possible fill: bluish and dark gray, very moist to wet, very soft, ~50% clay	8
					9
MC	2	$w_c = 12.2\%$			10
	4	$\gamma_d = 119.7 \text{ pcf}$			10
	4	$U_c = 0.35 \text{ ksf}$			11
				ORGANIC FAT CLAY (CH/OH) -- bay mud: dark gray and brownish gray, silty, wet, soft, few plant fragments, faint H ₂ S odor	12
					13
					14
MC	2	$O_c = 12.5\%$			15
	2	$w_c = 106.1\%$			15
	2	$\gamma_d = 42.4 \text{ pcf}$			15
		$U_c = 0.52 \text{ ksf}$			16
					17
					18
				grades stiffer, sandy, gravelly, with 1/4- to 1/2-in. fragments of sandstone	18
MC	8			with lenses of clayey gravel (angular, to 1 1/2 in. diam.), calcite filaments, visible plant fragments	19

DAC132-2007

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-4
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Project 887-0715G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: June 23, 2016	Drill Rig: CME 75	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater: no free gw accumulated	Boring Log BG-7 cont.			Logged by FJG

	Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
21	MC	8 11			ORGANIC FAT CLAY (CH/OH) — bay mud: continued	21
22						22
23						23
24						24
25	SPT	10 20 20			CLAYEY GRAVEL (GC) — colluvium: mottled, very moist, dense, angular shale and sandstone fragments up to 1½ in. diam.	25
26						26
27	SPT	50/4"			SANDSTONE — KJfs: gray, moist, moderately soft	27
28					Boring backfilled with grout immediately after drilling.	28
29						29
30						30
31						31
32						32
33						33
34						34
35						35
36						36
37						37
38						38
39						39

DAC132-2007

	LGVS D Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date: July 2018	Sheet A-5
		Reviewed By: DA	
		Proj. Manager: DA	
		Project No.: 887-0715G	

Project 887-0715G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: June 22, 2016	Drill Rig: CME 75	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater: no free gw accumulated	Boring Log BG-8			Logged by FJG

	Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
					A.C.	
1					P.G. GRAVEL W SILT AND SAND (GP-GM) — fill: brownish gray, damp, very dense	1
2					SHALE — KJfs: gray, dry, soft	2
3						3
4						4
5	SPT	40 50/4"				5
6					Boring backfilled with bentonite pellets immediately after drilling.	6
7						7
8						8
9						9
10						10
11						11
12						12
13						13
14						14
15						15
16						16
17						17
18						18
19						19

DAC132-2007

	LGVS Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-6
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Project 887-0715G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: June 22, 2016	Drill Rig: CME 75	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater at 6½ ft bgs immed. after drilling	Boring Log BG-9			Logged by FJG

	Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
					A.C.	
1					CLAYEY GRAVEL (GC) -- fill: brownish gray, damp, very dense	1
2						2
3						3
4						4
5	SPT	2	w _n = 5.0% <#200 = 2%		P.G. SAND (SP) -- tidal channel sand: brown, moist, very loose, with clam shell fragments	5
6		2				6
7		2				
8			▽		CLAYEY GRAVEL (GC) -- colluvium: dark brown, wet, medium dense free groundwater measured at 6½ ft bgs immediately after drilling	8
9					SHALE -- KJfs: dark gray, wet, very soft rock/stiff soil, highly sheared, inte	9
10	SPT	5				10
11		8				11
12		7				12
13					more-difficult drilling at 13 ft	13
14	SPT	17				14
15		20				15
16		21			Boring backfilled with grout immediately after drilling.	16
17						17
18						18
19						19

DAC 132-200

	LGVSD Secondary Treatment Upgrades	Report Date:	July 2018	Sheet A-7
	300 Smith Ranch Road, San Rafael, CA	Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

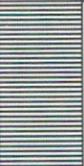
Project 887-0715G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: June 23, 2016	Drill Rig: CME 75	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater: no free gw accumulated	Boring Log BG-10			Logged by FJG

	Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)
1					P.G. GRAVEL W SILT AND SAND (GP-GM) — fill: grayish brown, damp, very dense, 15% silt, 20% sand	1
2						2
3						3
4						4
5	SPT	2	$w_n = 67.5\%$ $O_c = 9.8\%$		ORGANIC FAT CLAY (CH/OH) — bay mud: dark gray, very moist, very soft to soft, abundant plant fragments, faint H₂S odor	5
6		2				6
7		2				7
8					very soft, peaty (OH)	8
9						9
10	MC	2	$w_c = 152.8\%$ $\gamma_d = 29.9$ pcf $U_c = 0.81$ ksf		wet	10
11		2				11
12		2				12
13						13
14					less peat, strong H ₂ S odor	14
15	MC	1				15
16		2				16
17		1				17
18						18
19	MC	1			firm	19

DAC132-200

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-8
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Project 887-0715G	LGVWT Facility, 300 Smith Ranch Road, San Rafael		Driller: Clear Heart
Date: June 23, 2016	Drill Rig: CME 75	Hollow-stem auger	Hammer: 140 pound
Groundwater: no free gw accumulated	Boring Log BG-10 cont.		Logged by FJG

	Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
21	MC	2 5	w _c = 74.5% γ _d = 49.0 pcf U _c = 1.05 ksf		ORGANIC FAT CLAY (CH/OH) -- bay mud: continued at 21 ft, abundant gravel and sand (gray angular sandstone up to 2 in. diam.) grades stiffer at 22	21 22
24	<hr style="border-top: 1px dashed black;"/>					
25	SPT	16 15 20			GRAVELLY FAT CLAY (CH) -- colluvium: greenish gray, very moist, hard, 40% angular sand and gravel up to 1 in. diam.	25
26	<hr style="border-top: 1px dashed black;"/>					
27	SPT	50/4"			SANDSTONE -- KJfs: gray, dry, moderately hard	27
27	Boring backfilled with grout immediately after drilling.					
28						28
29						29
30						30
31						31
32						32
33						33
34						34
35						35
36						36
37						37
38						38
39						39

DAC132-2007

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-9
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Project 887-0715G		LGVWT Facility, 300 Smith Ranch Road, San Rafael		Page 1 of 3	Driller: Gregg
Date: March 26, 2018		Drill Rig: CME 850	Mud-rotary rig	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater not measured		Boring Log BG-11			Logged by FJG
Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
				CLAYEY GRAVEL (GC) -- fill: greenish brown, wet, loose, 25% fines, very angular hard gravel up to 1 in. diam.	
1					1
2					2
3					3
4					4
5					5
6	SPT	3			6
7		4			7
8		5			8
9				medium dense	9
10					10
11	SPT	1			11
12		1			12
13		4			13
14				CLAY (CH) -- bay mud: gray, wet, very soft, H₂S odor	14
15				hole caving and obstructed by cobbles, casing installed 0 to 15 ft	15
16	MC	2			16
17		1		only gravelly slough in MC sampler, false blow counts	17
18	SPT	2			18
19		0		SPT sampler driven only by weight of tools, zero blows	19
		0		soft, with minor brown peaty lamina	19

DAC132-200

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-10
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Project 887-0715G		LGVWT Facility, 300 Smith Ranch Road, San Rafael			Page 2 of 3	Driller: Gregg
Date: March 26, 2018		Drill Rig: CME 850	Mud-rotary rig	Hammer: 140 pound	Borehole diam.: 6 in.	
Groundwater not measured		Boring Log BG-11				Logged by FJG
	Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
21	MC	1 2 2			CLAY (CH) -- bay mud: gray, wet, soft, H ₂ S odor, minor brown peaty lamina	21
22						22
23						23
24					dark and light gray mottling, few percent sand	24
25	MC	0 2 3				25
26						26
27						27
28						28
29					CLAY (CL) -- colluvium: yellowish brown with multicolored specks, moist, very stiff, 15% sand and fine gravel as fragments of weathered and fresh local bedrock up to ¼ in. diam.	29
30	MC	9 14 22				30
31						31
32						32
33						33
34					CLAY (CL) -- highly weath. KJfs: brownish gray, moist, hard, 20% sand and subrounded gravel up to ½ in. diam., vaguely sheared convoluted fabric	34
35	SPT	9 15 19				35
36						36
37						37
38						38
39					markedly greater drilling resistance at 39 ft SHALE and GRAYWACKE -- KJfs: dark gray, hard, white calcite veins making up 3% of rock, bedding 25-50°	39

DAC132-2007

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-11
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Project 887-0715G		LGVWT Facility, 300 Smith Ranch Road, San Rafael			Page 3 of 3	Driller: Gregg
Date: March 26, 2018		Drill Rig: CME 850	Mud-rotary rig	Hammer: 140 pound	Borehole diam.: 6 in.	
Groundwater not measured		Boring Log BG-11				Logged by FJG
	Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)
41				[Graphic Log]	SHALE and GRAYWACKE — — KJfss: dark gray, hard, white calcite veins making up 3% of rock, bedding 25-50 changed to HQ3 coring tools at 40 ft	41
42					Run 40-43 ft: no recovery, hard gray sandstone stuck in inner barrel ground through material	42
43						43
44						44
45					Run 43-45½ ft: 60% recovery, RQD=0, pieces ½ to 3 in., NR probably is smaller pieces washed away	45
46						46
47					Run 45½-47½ ft: 100% recovery, RQD=77%, includes pieces 4, 5, and 9½ in. long	47
48						48
49					Run 47½-50½ ft: 100% recovery, RQD=51%, includes pieces 9 and 9½ in. long	49
50						50
51					Bottom of boring at 50½ ft.	51
52						52
53						53
54						54
55						55
56						56
57						57
58						58
59						59

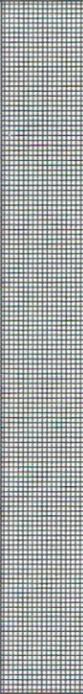
DAC132-200

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-12
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Project 887-0715G		LGVWT Facility, 300 Smith Ranch Road, San Rafael			Page 1 of 2	Driller: Gregg	
Date: March 26, 2018		Drill Rig: CME 850	Mud-rotary rig	Hammer: 140 pound	Borehole diam.: 6 in.		
Groundwater not measured		Boring Log BG-12				Logged by FJG	
Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)		
				CLAYEY GRAVEL (GC) -- fill: brownish gray, wet, loose, very angular gravel	1		
					2		
					3		
					4		
					5		
SPT	3				6		
	6				7		
	7				8		
					9		
				medium dense	10		
SPT	10				11		
	13				12		
	15				13		
				SHALE and GRAYWACKE -- KJfss: dark gray, wet, intensely sheared to friable rock or dense (clayey gravel) soil, clasts up to 2 (4?) in. diam.	14		
				Generally drills smoothly and easily (1 ft/min) using tricone bit, except in (4-in.?) blocks at 1- to 2-ft intervals, where drilling is about 1/3 the speed	15		
MC	28				16		
	28				17		
	36				18		
					19		

DACT 32-2007

	LGVSD Secondary Treatment Upgrades	Report Date:	July 2018	Sheet
	300 Smith Ranch Road, San Rafael, CA	Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	
				A-13

Project 887-0715G		LGVWT Facility, 300 Smith Ranch Road, San Rafael			Page 2 of 2	Driller: Gregg	
Date: March 26, 2018		Drill Rig: CME 850	Mud-rotary rig	Hammer: 140 pound	Borehole diam.: 6 in.		
Groundwater not measured		Boring Log BG-12				Logged by FJG	
Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)		
21	SPT 38 21 27			SHALE and GRAYWACKE -- KJfss: dark gray, wet, intensely sheared to friable rock or dense (clayey gravel) soil, clasts up to 2 (4?) in. diam. very dense if material were logged as soil	21		
22		22					
23		23					
24		24					
25	SPT 26 35 36				25		
26		26					
27		27					
28		28					
29		29					
30	SPT 50/3"				30		
31		Bottom of boring at 30½ ft.		31			
32				32			
33				33			
34				34			
35				35			
36				36			
37				37			
38				38			
39				39			

DAC132-2007

	LGVSD Secondary Treatment Upgrades	Report Date:	July 2018	Sheet
	300 Smith Ranch Road,	Reviewed By:	DA	
	San Rafael, CA	Proj. Manager:	DA	
		Project No.:	887-0715G	
				A-14

Project 887-0715G		LGVWT Facility, 300 Smith Ranch Road, San Rafael			page 1 of 1	Driller: Gregg	
Date: March 26, 2018		Drill Rig: CME 850	Hollow-stem augers	Hammer: 140 pound	Borehole diam.: 6 in.		
No groundwater observed		Boring Log BG-13				Logged by FJG	
Sample type	Blow count	Test results	Graphic log	Material descriptions	Depth (ft)		
				CLAYEY GRAVEL (GC) -- fill: brown, damp	1		
					2		
					3		
					4		
				SANDY CLAY (CL) to CLAYEY GRAVEL (GC) -- colluvium: mottled yellowish brown and gray (native-looking mottling), moist, medium dense, variable angular local rock fragments up to 1 in. diam.	5		
SPT	5				6		
	7				7		
	9				8		
					9		
SPT	40			SHALE and GRAYWACKE -- KJfss: dbrown and gray, dry to damp, closely fractured, moderately hard	10		
	43			slow, noisy drilling 10-13 ft	11		
	40/3"				12		
					13		
SPT	30/3"			Bottom of boring at 13 ft.	14		
					15		
					16		
					17		
					18		
					19		

DAC 132-2007

	LGVSD Secondary Treatment Upgrades 300 Smith Ranch Road, San Rafael, CA	Report Date:	July 2018	Sheet A-15
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	887-0715G	

Appendix B

Laboratory Test Results

Soil Mechanics Lab

**Organic Matter
ASTM D 2974 - 87 Meth 'C' - 440°C**

Sample No.		BG-7	BG-10		
Depth	ft	15-15.5	5-5.5		
Crucible No.		7	20		
Soil & Crucible (oven dry) g		22.95	21.57		
Soil & Crucible 440°C 1 g		21.85	20.75		
440°C 2 g		21.63	20.50		
440°C 3 g		21.62	20.50		
440°C 4 g		—	—		
Crucible	g	12.34	10.61		
Organic Matter	%	12.5	9.8		
Notes/Remarks: ----- ----- -----					

DAC101-2003

Project 887

Report Date:	July 2018
Reviewed By:	DA
Proj. Manager:	DA
Job No.:	887-0715G

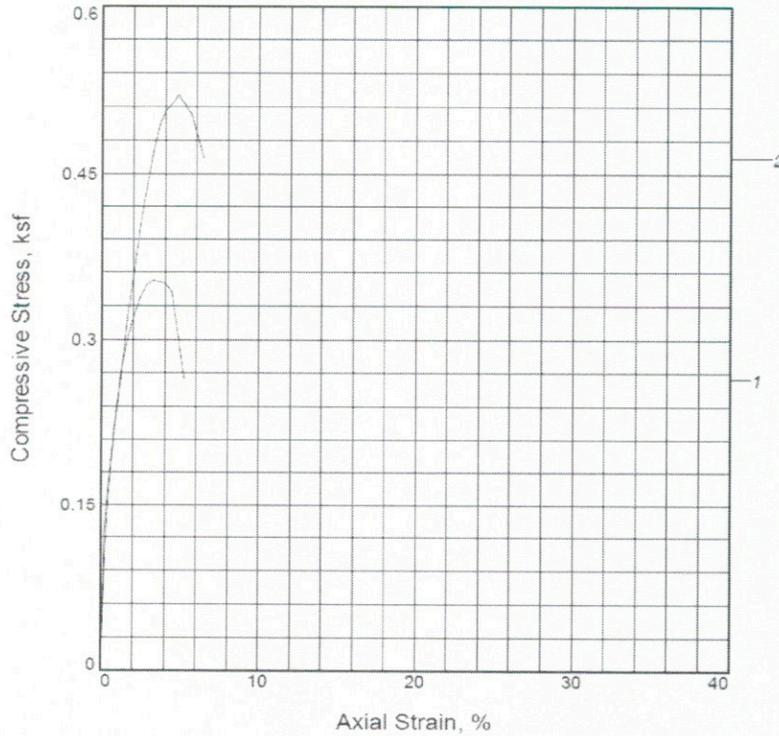
Laboratory Test Results

**LGVSD Secondary Treatment Upgrades
300 Smith Ranch Road, San Rafael, CA**



B-1

UNCONFINED COMPRESSION TEST



Sample No.	1	2	
Unconfined strength, ksf	0.35	0.52	
Undrained shear strength, ksf	0.17	0.26	
Failure strain, %	2.8	4.8	
Strain rate, %/min.	0.08	0.08	
Water content, %	12.2	106.1	
Wet density, pcf	134.4	87.4	
Dry density, pcf	119.7	42.4	
Saturation, %	80.9	96.2	
Void ratio	0.4079	2.9758	
Specimen diameter, in.	2.42	2.42	
Specimen height, in.	4.95	4.95	
Height/diameter ratio	2.05	2.05	

Description: See remarks

LL = **PL =** **PI =** **Assumed GS= 2.70** **Type: Mod.Cal.**

Project No.: 887-0715G

Date Sampled:

Remarks:

#1/ 10-10.5': Soft, dark gray clayey

GRAVEL(GC).

#2/ Soft, black FAT CLAY(CH/OH)w/
organics.

Plate _____

Client: DAC Associates

Project: 300 Smith Ranch Road

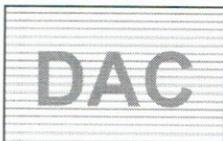
Location: B-7

Depth: 15-15.5'

UNCONFINED COMPRESSION TEST

Soil Mechanics Lab

Oakland, California



Lab Test Results

**LGVSD Secondary
Treatment Upgrades
300 Smith Ranch Road,
San Rafael, CA**

Report Date: July 2018

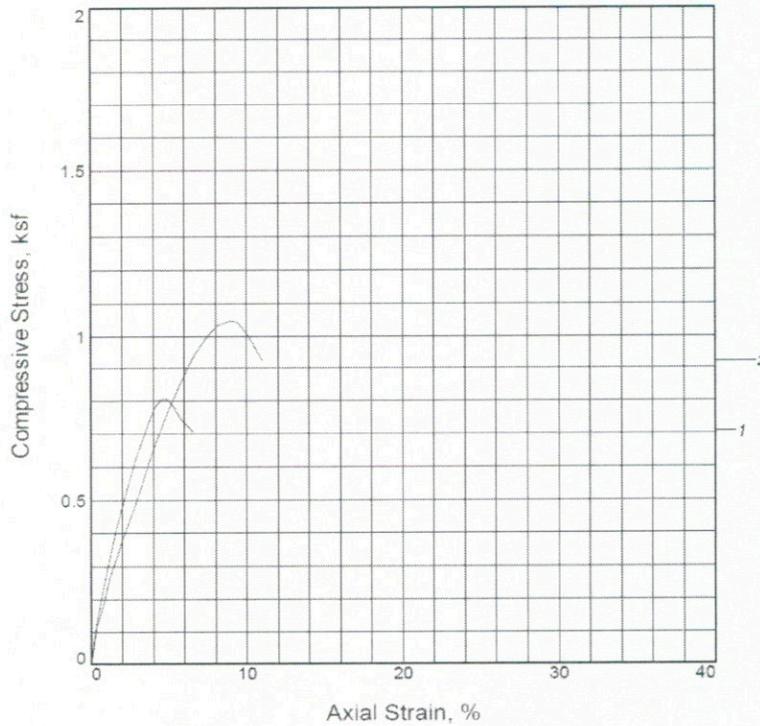
Reviewed By: DA

Proj. Manager: DA

Job No. 887-0715G

B-2

UNCONFINED COMPRESSION TEST



Sample No.	1	2	
Unconfined strength, ksf	0.81	1.05	
Undrained shear strength, ksf	0.40	0.52	
Failure strain, %	4.9	9.0	
Strain rate, %/min.	0.08	0.08	
Water content, %	152.8	74.5	
Wet density, pcf	75.7	85.5	
Dry density, pcf	29.9	49.0	
Saturation, %	90.7	85.2	
Void ratio	4.2110	2.1846	
Specimen diameter, in.	2.42	2.42	
Specimen height, in.	4.90	4.90	
Height/diameter ratio	2.03	2.03	

Description: See remarks

LL = **PL =** **PI =** **Assumed GS= 2.50** **Type: Mod.Cal.**

Project No.: 887-0715G

Date Sampled:

Remarks:

#1/ Med.black FAT CLAY(CH/OH)w/
organics.

#2/ Med.black FAT CLAY(CH/OH)w/
organics.

Plate _____

Client: DAC Associates

Project: 300 Smith Ranch Road

Location: B-10

UNCONFINED COMPRESSION TEST
Soil Mechanics Lab
Oakland, California



Lab Test Results

**LGVSD Secondary
Treatment Upgrades
300 Smith Ranch Road,
San Rafael, CA**

Report Date:

July 2018

Reviewed By:

DA

Proj. Manager:

DA

Job No. 887-0715G

B-3

Appendix C

Rock Exposure Observations



Appendix C

Rock Exposure Observations

On June 23, 2016, we recorded observations of five rock exposures at the site. Their locations are shown on the map below. Structural attitudes are presented in dip-vector style, i.e., degrees azimuth, degrees of plunge. Descriptions of terms used to describe the hardness/strength and fracture density are presented in two tables on page C-4.

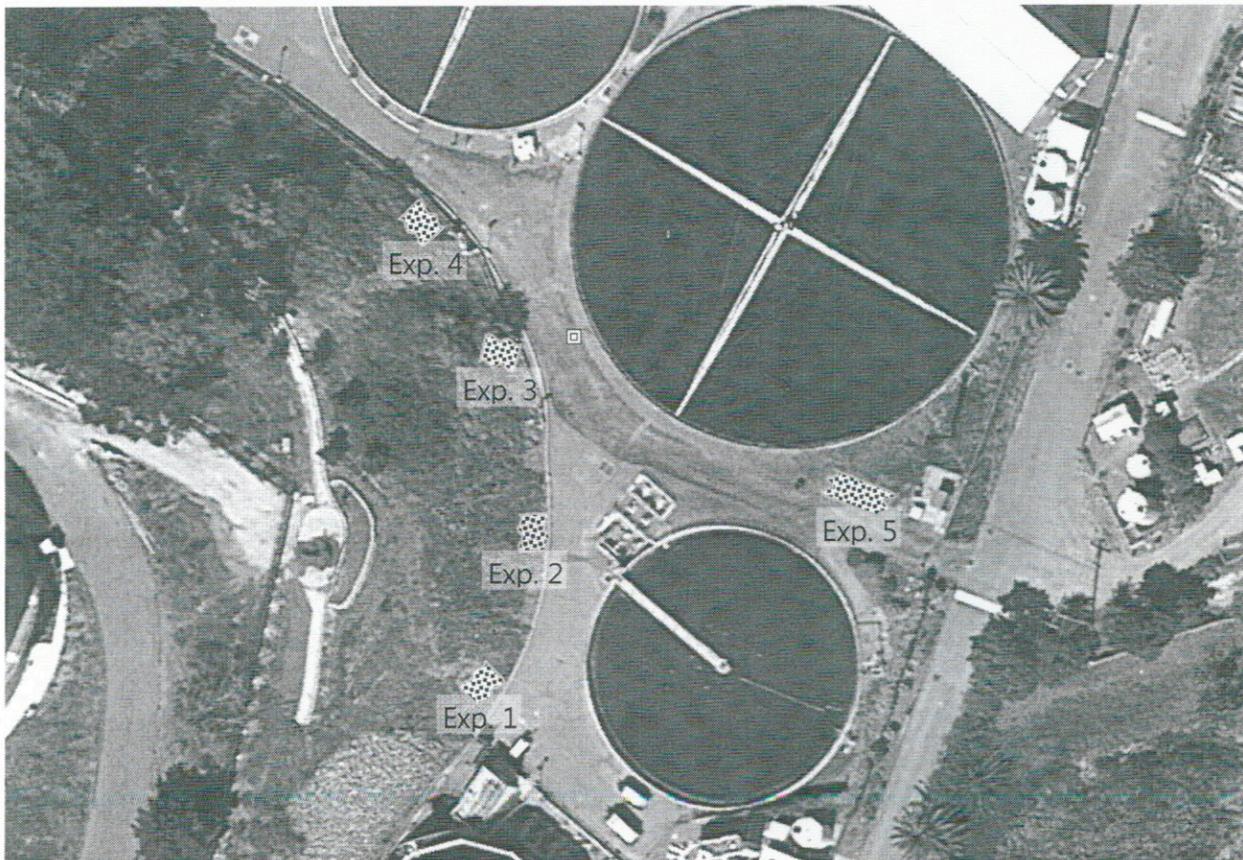


Figure C-1. Locations of five rock exposure observations.



Exposure 1



Sandstone
Moderately hard to hard,
fracture spacing ~1 in. average,
orientations random, not laterally continuous more
than a few ft, undulatory

Exposure 2



Sandstone
Hard, fracture spacing 2 in. to 2 ft,
prominent joint sets 135°, 26° (bedding?);
315°, 66°; 45°, 66°

Exposure 3



Siltstone
Bed 1½ ft thick, soft,
fracture spacing ⅛ to ½ in.,
thickly laminated, bedding 150°, 40°



Exposure 4



Sandstone
Hard, fracture spacing 1 in. to 1½ ft

Exposure 5



Bedrock exposed here below
0 to 2 in. of loose gravel

Sandstone
Moderately hard, faintly thickly
laminated, fracture spacing ½ to 3 in.



Table C-1 Rock hardness/strength

Term	Description
Extremely hard	Core, fragment, or exposure cannot be scratched with knife or sharp pick. Can only be chipped with repeated heavy hammer blows.
Very hard	Specimen cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.
Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.
Moderately hard	Can be scratched with knife or sharp pick with light or moderate pressure. Core or fragment breaks with moderate hammer blow.
Moderately soft	Can be grooved 2 mm (¹ / ₁₆ in.) deep by knife or sharp pick with moderate or heavy pressure. Breaks with light hammer blow or heavy manual pressure.
Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
Very soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.

 Source: California Department of Transportation, Office of Structural Foundations

Table C-2 Rock fracture density

Term	Spacing (U.S. customary)	Spacing (metric)
Very intensely fractured	Chips < 0.1 ft	Chips < 3 cm
Intensely fractured	0.1–0.3 ft	3–10 cm
Moderately fractured	0.3–1 ft	10–30 cm
Slightly fractured	1–3 ft	30 cm to 1 m
Very slightly fractured	> 3 ft	> 1 m
Unfractured	No fractures	No fractures

 Source: California Department of Transportation, Office of Structural Foundations

Appendix D

Boring Logs, DAC Associates (2011)

Project # 568-1011G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Ofiario
Date: April 4, 2011	Drill Rig: SIMCO		Hammer:	140 pound
Groundwater depth: 8 ft.	Boring Log BG-1			Drilled by: DA

Depth (ft)	Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)
1					pavement: 2 in. asphaltic concrete over 6 in. aggregate base rock	1
2					CLAYEY GRAVEL (GC) -- fill: dark brown, damp high drilling resistance refusal on boulder(?), boring location shifted slightly west	2
3						3
4						4
5					cuttings are dark grayish brown, moist, clayey, some gravel	5
6					CLAY (CH) -- bay mud: dark gray	6
7	MC	3			sampler initially returned empty, redeployed with catcher	7
8		4			groundwater encountered at 8 ft.	8
9		4				9
10					CLAYEY SAND (SC) to SANDY CLAY (CL) -- residual soil: dark brown, moist	10
11					SANDSTONE -- bedrock: brown, sandy, damp to dry, highly weathered, trace clay high drilling resistance	11
12	SPT	50				12
13						13
14						14
15						15
16						16
17						17
18						18
19						19

Bottom of boring at 12.5 feet.

	LGVWT Facility 300 Smith Ranch Rd, San Rafael, CA	Report Date:	April 2011	Sheet A-1
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	568-1011G	

Project # 568-1011G	LGWWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Ofiaro
Date: April 4, 2011	Drill Rig: SIMCO		Hammer: 140 pound	Borehole diam.: 4 inches
Groundwater depth: ___ ft.	Boring Log BG-2			Drilled by: DA

Depth (ft)	Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)
1					pavement: 2 in. asphaltic concrete over 6 in. aggregate base rock	1
2					GRAVELLY CLAY (CL) -- fill: brown, damp to dry, rock fragments are sandstone	2
3					drill cuttings exhibit greater clay content moisture content increases with depth	3
4						4
5						5
6					at 5 ft: brown, silty, fat clay, moist, firm to stiff	6
7	MC	1			SILTY CLAY (CH) -- bay mud: dark gray, firm to stiff, with fine sand, high plasticity, black and green rootlets, some organics	7
8		2				8
9		2				9
10						10
11					SANDY CLAY (CL) -- residual soil: dark grayish brown, moist	11
12						12
13					SANDSTONE -- bedrock: light brown, highly weathered, friable, silty, fine sand, damp to dry	13
14						14
15	SPT	50 for 2 in.				15
16						16
17						17
18						18
19						19

Bottom of boring at 15 feet.

	LGWWT Facility 300 Smith Ranch Rd, San Rafael, CA	Report Date: April 2011	Sheet A-2
		Reviewed By: DA	
		Proj. Manager: DA	
		Project No.: 568-1011G	

Project # 568-1011G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Ofiaro
Date: April 4, 2011	Drill Rig: SIMCO		Hammer: 140 pound	Borehole diam.: 4 inches
Groundwater depth: 4.5 ft.	Boring Log BG-3			Drilled by: DA

Depth (ft)	Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)
1					pavement: 2 in. asphaltic concrete over 8 in. aggregate base rock	1
2					CLAYEY GRAVEL (GC) — fill: grayish brown, damp to dry	2
3					grades darker gray and more moist	3
4					groundwater at 4.5 ft.	4
5	MC	6				5
6		4			SILTY CLAY (CH) — bay mud: brown to dark gray, wet, black pockets	6
7	SPT	3			gray, sandy	7
8		4				8
9						9
10					at 10 ft switched to hollow-stem drill to minimize hole collapse potential	10
11					at 10.5 ft peaty material evident	11
12					PEATY SILTY CLAY (OH) — bay mud : gray to dark gray, wet, very soft, strong organic odor, visible plant matter	12
13	MC	1				13
14		1				14
15		1				15
16	MC	1				16
17		2				17
18					organic content grades less	18
19					FAT CLAY (CH) — colluvium: gray to bluish gray, damp to moist, stiff to very stiff, pockets of weathered rock fragments, trace organic material	19
see Sheet A-4 for continuation						

	LGVWT Facility 300 Smith Ranch Rd, San Rafael, CA	Report Date: April 2011	Sheet A-3(a)
		Reviewed By: DA	
		Proj. Manager: DA	
		Project No.: 568-1011G	

Project # 568-1011G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Ofiaro
Date: April 4, 2011	Drill Rig: SIMCO		Hammer: 140 pound	Borehole diam.: 4 inches
Groundwater depth: ___ ft.	Boring Log BG-3			Drilled by: DA

Depth (ft)	Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)
21	MC	6 10 18			continued from above	21
22						22
23						23
24					dark gray	24
25					BASALT -- bedrock: dark greenish gray, weak angular fragments	25
26						26
27						27
28						28
29	MC	29 for 2 in.			drilling refusal at 29 ft 2 in.	29
30						30
31						31
32						32
33						33
34						34
35						35
36						36
37						37
38						38
39						39

Bottom of boring at 29 feet.

	LGVSD Facility 300 Smith Ranch Rd San Rafael, CA	Report Date: April 2011	Sheet A-3 (b)
		Reviewed By: DA	
		Proj. Manager: DA	
		Project No.: 568-1011G	

Appendix E

Boring Logs, DAC Associates (2015)

Project # 859-7714G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: Nov. 21, 2014	Drill Rig: Hino DR5K	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater depth: 8½ ft	Boring Log BG-1			Logged by FJG

Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)
				CLAYEY SAND W GRAVEL (SC) — fill: brownish gray, damp, medium dense, 35% fines	1
					2
					3
					4
				moist to wet	5
SPT	9	35.5% <#200			6
	7				7
	11				8
					9
				FAT/ORGANIC CLAY (CH/OH) — bay mud : dark gray, wet, soft, trace sand, with plant fragments, H ₂ S odor. GW at 8½ ft. based on water on center plug.	10
					11
MC	2	C _u = 0.34 ksf			12
	2	W _n = 42.7%			13
	2	γ _d = 78.6 pcf			14
					15
					16
MC	2	C _u = 0.38 ksf			17
	2	w _n = 121.3%			18
	3	γ _d = 36.0 pcf			19
					19

sandy lens (35% fine sand) 19½(?) — 20½ ft

	LGVSD Parking Lot Reclamation 300 Smith Ranch Rd San Rafael, CA	Report Date:	April, 2015	Sheet A-1
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	859-7714G	

Project # 859-7714G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: Nov. 21, 2014	Drill Rig: Hino DR5K	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater depth: 8½ ft	Boring Log BG-1 cont.			Logged by FJG

	Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)
21	MC	1 2 2	$w_n = 80.7\%$ $\gamma_d = 54.6 \text{ pcf}$		FAT/ORGANIC CLAY (CH/OH) — bay mud: dark gray, wet, soft, trace sand, with plant fragments, H ₂ S odor.	-21
22						-22
23						-23
24					very dark gray	-24
25					with ½-in. green sandy specks (weathered sandstone clasts)	-25
26	MC	1 3 5	$C_u = 0.33 \text{ ksf}$ $w_n = 27.9\%$ $\gamma_d = 97.4 \text{ pcf}$		firm	-26
27					slow drilling starting at 28 ft	-27
28					GRAVELLY CLAY (CL) — colluvium: brown, moist, stiff, angular gravel up to 1 in. diam.	-28
29						-29
30	SPT	50/4"			SANDSTONE — KJf: green grading down to yellowish brown, damp, very soft to soft (rock terminology), faint relict fracture structure	-30
31					Bottom of boring at 30½ ft. Less than 1 ft of water in bottom of hole. Hole grouted immediately after drilling.	-31
32						-32
33						-33
34						-34
35						-35
36						-36
37						-37
38						-38
39						-39

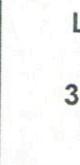
	LGVSD Parking Lot Reclamation		Report Date:	April, 2015	Sheet
	300 Smith Ranch Rd		Reviewed By:	DA	
	San Rafael, CA		Proj. Manager:	DA	
			Project No.:	859-7714G	

Project # 859-7714G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: Nov. 21, 2014	Drill Rig: Hino DR5K	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.

Groundwater depth:

Boring Log BG-2

Logged by FJG

Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)
				CLAYEY SAND W GRAVEL (SC) — fill: brownish gray, damp, medium dense, 35% fines	1
					2
					3
					4
					5
SPT	3				6
	3	6.6% >#200		FAT/ORGANIC CLAY (CH) — bay mud: dark gray, wet, firm, trace sand, with plant fragments, H ₂ S odor.	6
	4			soft	7
					8
					9
					10
MC	2	C _u = 0.45 ksf			10
	2	mc = 149%			11
	2	dd = 37.6 pcf			11
					12
					13
					14
					15
MC	1				15
	2				16
	2				16
					17
					18
					19



LGVSD Parking Lot
Reclamation
300 Smith Ranch Rd
San Rafael, CA

Report Date:	April, 2015
Reviewed By:	DA
Proj. Manager:	DA
Project No.:	859-7714G

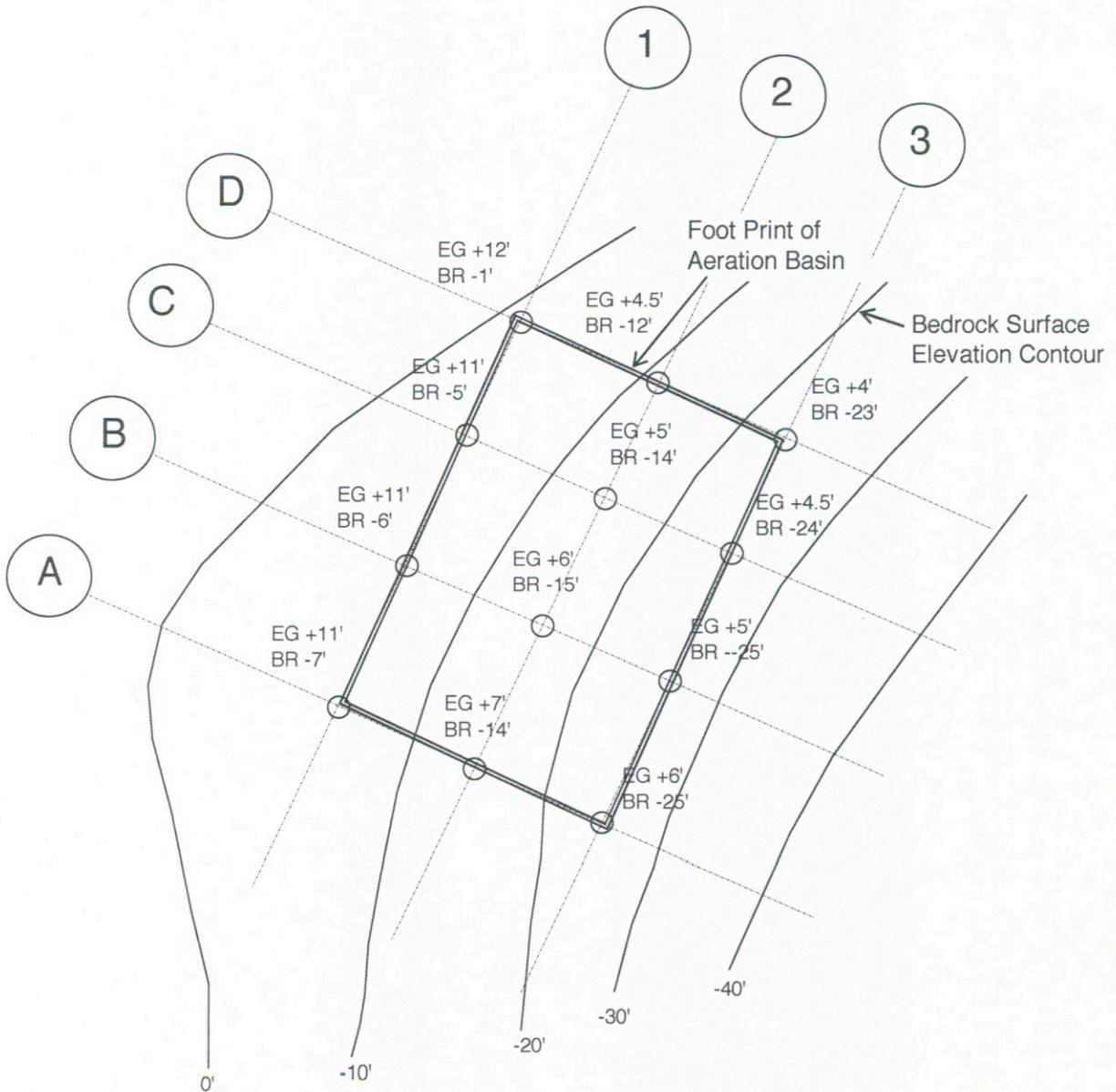
Sheet
A-3

Project # 859-7714G	LGVWT Facility, 300 Smith Ranch Road, San Rafael			Driller: Clear Heart
Date: Nov. 21, 2014	Drill Rig: Hino DR5K	Hollow-stem auger	Hammer: 140 pound	Borehole diam.: 6 in.
Groundwater depth:	Boring Log BG-2 cont.			Logged by FJG

	Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)
21	MC	1 2 2	$C_u = 0.52$ ksf wn = 104.6% yd = 47.5 pcf		FAT/ORGANIC CLAY (CH) — bay mud: dark gray, wet, soft, trace sand, with plant fragments, H ₂ S odor.	-21
22						-22
23						-23
24						-24
25	MC	2 5 12	$C_u = 1.13$ ksf wn = 20.2% yd = 107.7 pcf		stiff	-25
26						-26
27						-27
28					slow drilling starting at 28 ft; possible colluvium or weathered bedrock	-28
29						-29
30	SPT	25 32 50			SHALE — KJf: brownish gray, damp, soft to very soft (rock terminology), sheared, clayey, has appearance of shear-zone material	-30
31						-31
32					Bottom of boring at 31½ ft. Less than 1 ft of water in bottom of hole. Hole grouted immediately after drilling.	-32
33						-33
34						-34
35						-35
36						-36
37						-37
38						-38
39						-39

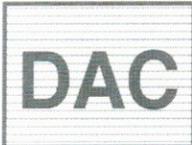
	LGVSD Parking Lot Reclamation 300 Smith Ranch Rd San Rafael, CA	Report Date:	April. 2015	Sheet A-4
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	859-7714G	

Appendix F
Strength-Based Analysis
of Drilled Pier Capacity



New Proposed Location of Aeration Basin

NTS



Calculation Sheet

Subject: Engineering Calculations

Project Name: LGVSD Secondary Treatment and RWTF Upgrade

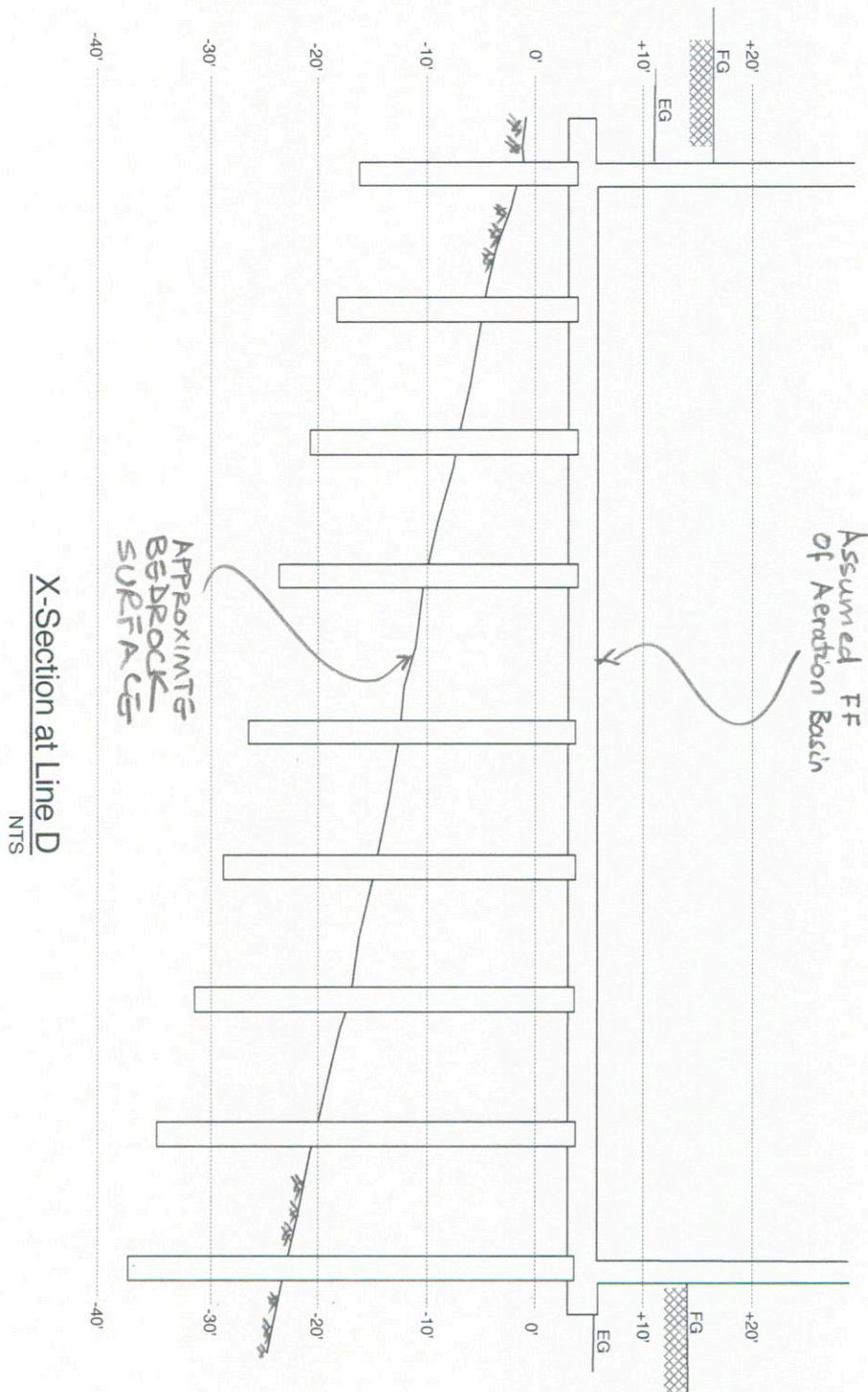
Project Location: 300 Smith Ranch Road, San Rafael, CA

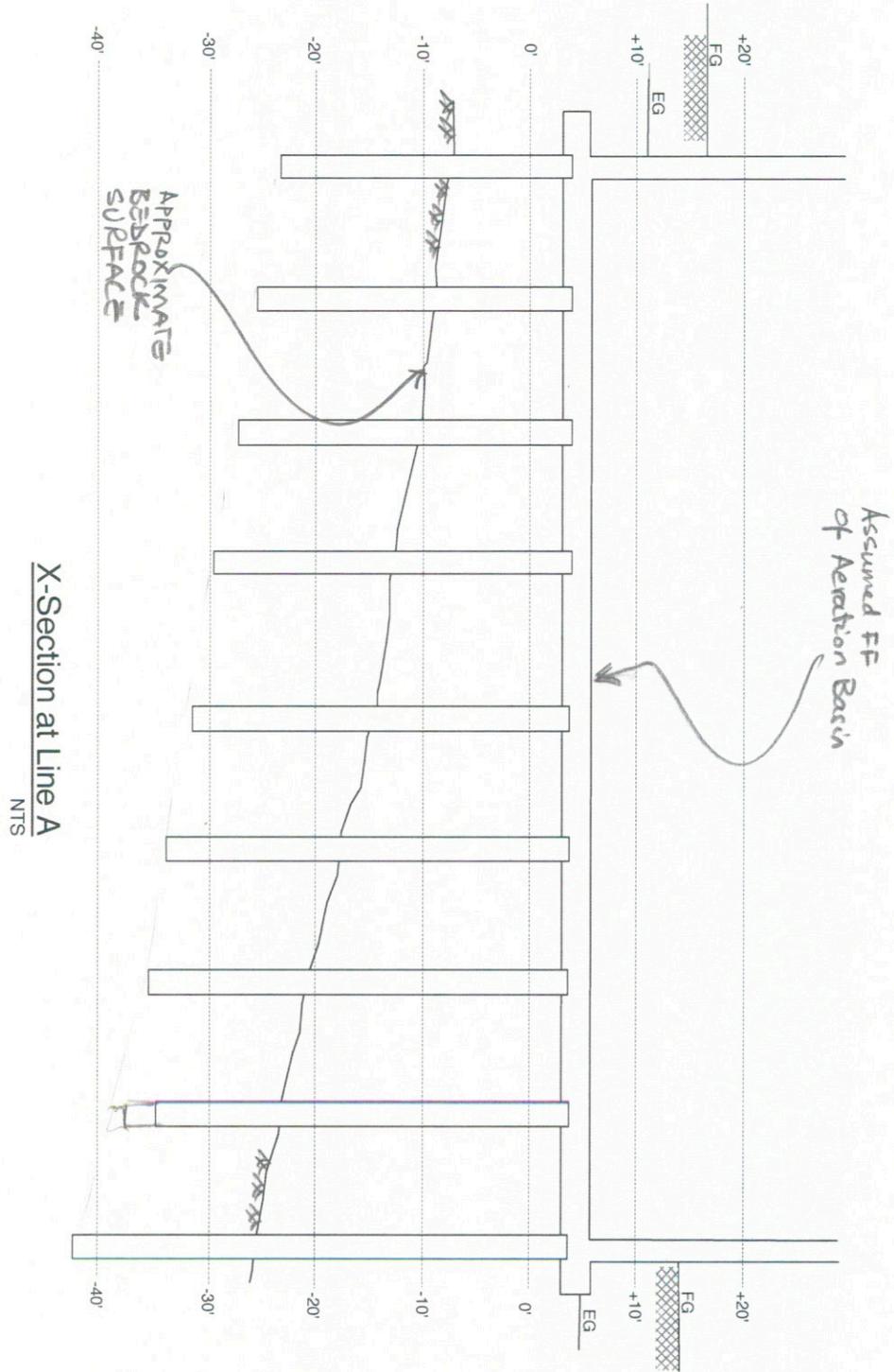
Project No.: 887-0715G

By: DA Checked By: DA

Page 2 of 8

Date: April 3, 2018







From: Improvement of the Geotechnical Axial Design Methodology..... (July 2003)

Table 5.3. Test Data Obtained within or around the Bedrock Socket for all Test Shafts

Site	Rock Type	O-Cell Load Test			UC Test	PM Test	SPT-N
		f _{max} (ksf)	f _{all} (ksf)	f _d (ksf)	q _{ui} (ksf)	E _m (ksf)	(bpf)
I-225	Soil-Like Claystone	2.6	1.3	1.8	8.3	970	32
		3.6	1.8	2.8	12.3	2550	55
		3.1	1.6	2.3	10	1513	41
County line		3.4	1.7	3.0	10.4	1800	38
Franklin	Very Hard Sandy Claystone	19	8.5	19	64	11050	50/4"
Broadway	Very Hard Clayey Sandstone	17	8.5	15.9	97	8900	50/3"
		35.1	17.5	32.8	210	23448	*50/2"
		24	12	22.4	145	15025	*50/2.5"

* Roughly estimated data based on the results of Table 5.2.

Based on the results of our supplemental exploratory borings, the bedrock should be considered as hard to very hard sandstone & shale. Material is defined as SPT-N > 80 bpf.



From: Improvement of the Geotechnical Axial Design Methodology..... (July 2003)

Table 5.5. Best-Fit Design Equations for Drilled Shafts Based on the Results of Load Tests, and SPT, UC, and PM Tests

Description	Soil-Like Claystone (I-25@ I-225 and County Line)	Very Hard Sandy Claystone (I-25@ Franklin)	Very Hard Clayey Sandstone (I-25@ Broadway)
Note: Units are ksf for all strength, resistance, and stiffness values, bpf for SPT- N values, ft for D, and ft ² for A _s and A _b			
SPT- Based Design Method for Side Resistance	$f_{max} = 0.075 N$, $f_{all} = 0.037 N$, $f_d = 0.06 N$	N/A. Future research should investigate design methods based on SPT N values for the very hard claystone and sandstone bedrock, (see Chapter 6).	
SPT- Based Method for Base Resistance	$q_{max} = 0.92 N$; $q_{all} = 0.46 N$, $q_d = 0.42 N$		
Strength- Based Design Method for Side Resistance	$f_{max} = 0.30 q_{ui}$, $f_{all} = 0.15 q_{ui}$ $f_d = 0.24 q_{ui}$		
Strength- Based Design Method for Base Resistance	$q_{max} = 3.8 q_{ui}$; $q_{all} = 1.9 q_{ui}$; $q_d = 1.7 q_{ui}$	$f_d = f_{max} = 0.3 q_{ui}$	$q_{max} = 1.45 q_{ui}$; $q_{all} = 0.73 q_{ui}$; $q_d = 0.32 q_{ui}$;
Stiffness- Based Design Equations	$f_d = 0.0019 E_m$	$f_d = f_{max} = 0.0017 E_m$	
	$f_d = 0.0018 E_m$		
Very Approximate Load-Settlement Curve for Rigid Shafts as a function of q_{ui} and SPT-N values. *	Three points: (0,0), (Q_d , 0.01D), (Q_{max} , 0.05D) Q_d (ksf) = $A_s f_d + A_b q_d$; Q_{max} (ksf) = $A_s f_{max} + A_b q_{max}$ The relations for f_{max} , f_d , q_{max} , q_d as a function of N and q_{ui} are listed above; D is the shaft diameter; A_b and A_s are, respectively, the base and side areas of the rock socket.		

* Follow the procedure in Chapter 3 to account for the compressibility of high-capacity shafts embedded in very hard claystone and sandstone. No correction is needed for the low-capacity shafts embedded in soil-like claystone.



Allowable Skin Friction Resistance in Bedrock

Use Best-Fit Design Equations Table 5.5
(Report No. CDOT-DTD-R-2003-6: Improvement of the Geotechnical Axial Design Methodology For Colorado's Drilled Shafts Socketed in Weak Rocks)

Consider v. hard sandy claystone $N > 80$

Strength-Based Design for side Resistance:

$$f_{max} = 0.30 q_{ui} \quad f_{all} = 0.15 q_{ui}$$

$$f_d = f_{max} = 0.30 q_{ui}$$

Based on Table 5.3 for Very Hard Sandy Claystone

$$q_{ui} = 64 \text{ ksf with an SPT-}'N' \text{ value of } 50/4''$$

$$\therefore f_{max} = 0.30 q_{ui}$$

$$= 64 \times 0.3 = 19.2 \text{ ksf}$$

$$f_{all} = \frac{19.2}{2.0} = 9.6 \text{ ksf}$$

$$f_d = 19.2 \text{ ksf for a}$$

Settlement $\approx 0.01 D$

$$\Delta_s = 0.01 \times 24'' = 0.24''$$



Allowable End Bearing Resistance in Bedrock

Again using the best fit design equation Table 5.5

$$q_{\max} = 3.8 q_{ui} = 243.2 \text{ ksf}$$

$$q_{\text{all}} = 1.9 q_{ui} = 121.6 \text{ ksf}$$

$$q_d = 1.7 q_{ui} = 108.8 \text{ ksf}$$

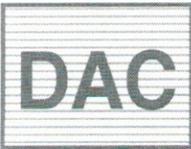
The above capacities would apply to areas where bedrock consisted of hard sandstone - shale material.

Assume a minimum embedment of 10-ft into competent bedrock:

$$R_{SF} = \pi D \times 10 \times 9.6 = 603 \text{ kip}$$

$$Q_{EB} = \pi D^2 / 4 \times 108.8 = 342 \text{ kip}$$

$$Q_{\text{TOTAL}} = 603 + 342 = 945 \text{ kips}$$



Negative skin Friction

NAVFAC DM 7.2-211

$$f_n = \beta P'_o$$

unit negative skin friction Effective vertical stress

$\beta = 0.2$ To 0.25 for clays
 0.25 to 0.35 " Silts
 0.35 to 0.50 " Sands

Assume 15' of compacted granular fill &
 " 20' of soft Bay Mud.

$$\gamma_{fill} = 110 \text{ pcf}$$

$$\text{Average } P'_{o_{fill}} = \frac{15 \times 110}{2} = 825 \text{ pcf}$$

$$\gamma_{BM} = 98 \text{ pcf}$$

$$\text{Average } P'_{o_{BM}} = \frac{20 \times (98 - 62)}{2} + 825 = 1185 \text{ pcf}$$

$$F_{DD} = \left\{ (\beta_1 \times P'_{o_{fill}}) \times 15 + (\beta_2 \times P'_{o_{BM}}) \times 20 \right\} \pi D$$

$$= \left\{ 0.45 \times 825 \times 15 + 0.25 \times 1185 \times 20 \right\} 3.14 \times 2$$

$$= \left\{ 5569 + 5925 \right\} \times 2\pi = 72,217 \#$$

$$= 72.2 \text{ Kip}$$

NET ALLOWABLE COMPRESSION LOAD

$$Q_{allow} = Q_{TOTAL} - F_{DD} = 945 - 72 = 872 \text{ Kip}$$

$$Q'_{allowable} = \frac{Q_{allow}}{FS} = \frac{872}{2.5} = 348.8 \text{ SAY } 350 \text{ Kip}$$



Darius Abolhassani Consultant & Associates, Inc.

7 Mt. Lassen Dr., Suite A-129, San Rafael, CA 94903

(415) 499-1919 Email: darius@dacassociates.net

July 6, 2022

Mr. Eric Sahm, P.E.
Aqua Engineering
533 W 2600 S Suite 275
Bountiful, UT 84010

Re: Supplemental Geotechnical Investigation
Proposed New Sludge Holding Tank
Secondary Treatment Plant Upgrade
Las Gallinas Valley Sanitary District
300 Smith Ranch Road, San Rafael, CA
DAC Project No. 1313-3719C

Dear Mr. Sahm:

As requested, DAC Associates, Inc. (DAC) have performed a geotechnical investigation for a proposed sludge holding tank at the wastewater treatment facility belonging to Las Gallinas Valley Sanitary District. This report presents the results from our review of available pertinent geologic and seismic hazard information and from our field investigation and engineering analysis. The soil and foundation conditions are discussed, and recommendations for the soil and foundation engineering aspects of the project are presented. Conclusions and recommendations contained herein are based on applicable standards of our profession at the time this report was prepared. Copies of this report are furnished only to provide the factual data that were gathered and summarized.

INTRODUCTION

The Las Gallinas Valley wastewater treatment facility is located at 300 Smith Ranch Road, San Rafael, California. The proposed sludge holding tank will be located in a currently unoccupied area in the north-central part of the facility site, as shown in Figure 1. This location is currently a level area adjacent to a grit separator. The site coordinates are latitude 38.0256 north by longitude -122.5185 west.

Our understanding is that the site was previously occupied by a sludge thickener structure. This former structure was a round, concrete-lined tank with a diameter of about 33 ft and a height of about 16 ft. Its bottom sloped inward toward the center and ranged between elevations -1 to 3 ft above mean sea level (amsl). Its construction is shown on Sheets 4 and



6 of a set of drawings dated May 1975. A portion of Sheet 4, which includes a cross section through the thickener, is presented in Figure 1. The 1975 plans called for bay mud formerly present in the area to be excavated down to bedrock and replaced with drain rock up to about elevation 0 ft amsl. Above, the backfill under and alongside the sludge thickener was to consist of compacted backfill.

We understand that this sludge thickener was present until 2021, at which time it was removed. We understand that the thickener did not show signs of settling. Its removal was followed by backfilling of the excavation.

According to a drawing for the project sent by you to us, the proposed sludge holding tank will occupy an area formerly occupied by the sludge thickener. The new sludge tank will be a square-shaped structure measuring 22 ft on each side by a height of 14 ft. It will essentially be entirely buried below the existing ground surface, i.e., extend down to elevation -4 ft.

On June 16, 2022, we drilled one boring at the location of the proposed sludge tank (Figure 1). The log of the boring is presented in the Appendix. The boring was backfilled with grout, bentonite chips, and cuttings under the observation of an inspector from the County environmental health department. The adjacent hole was also backfilled at the same time.

This report has been prepared in accordance with generally accepted geotechnical engineering practices, and with our agreement with Aqua Engineering for the exclusive use of their consultants for specific application to the secondary treatment upgrades project. In the event there are any changes in the ownership, nature, design or location of the proposed project, the conclusions and recommendations contained in this report shall not be considered valid unless (1) the project changes are reviewed by our office and (2) the conclusions and recommendations presented in this report are modified or verified in writing.

Reliance on this report by others must be at their own risk unless we are consulted on its use or limitations. This study is purely a geotechnical investigation and it does not include any environmental examination or evaluation of the surface and/or subsurface conditions. We cannot be responsible for impacts of any changes in engineering and environmental standards, practices, or regulations subsequent to performance of services without our further consultation. We can neither vouch for the accuracy of information supplied by others nor accept consequences for unconsulted use of segregated portions of this report.

FINDINGS

On the morning of our drilling, we noted an existing vertical hole located about 4 ft northwest of our Boring BG-16. This hole was about 2 ft in diameter and 8.9 ft deep bgs. Groundwater was noted in the hole at a depth of 8.1 ft bgs.



Subsurface materials at the site, listed in downward succession, consist of general fill, drain rock, and bedrock. General fill, encountered from 0 ft bgs to a depth of 8 ft bgs (elevations 9 ft amsl down to 1 ft amsl), consisted of well-graded gravel and sand that was medium dense and damp to moist. Below, we encountered drain rock from 8 ft bgs down to 19 or 20 ft bgs (elevations 1 ft amsl to -10 or -11 ft). This material is a quarry product that was evidently placed in the bottom of the excavation for the sludge thickener in the 1970s. It was placed to replace any overexcavated bay mud and other soil. Bedrock consisting of Franciscan Complex shale was encountered below a depth of 19 or 20 ft bgs (elevation -10 or -11 ft). Note that no colluvium or bay mud was encountered; evidently, these materials were removed and replaced with drain rock in substantial conformance with the cross section shown in Figure 1B.

Thus, we anticipate that below the floor of the proposed sludge tank, there will be a layer of drain rock (overlying bedrock) ranging in thickness between about 2½ and 5½ ft thick.

The method of drilling and the timing and sealing of the boring allowed little time for equilibration of the groundwater and measurement of its true level. Instead, we measured groundwater in the existing hole located a few feet from our boring. In that hole, groundwater was measured at a depth of 8.1 ft bgs (elevation 1 ft amsl). Groundwater may be assumed to be at approximately sea level. Fluctuations and deviations in groundwater elevations will occur on seasonal and multi-year time scales due to variations in rainfall and surface and subsurface conditions.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our geotechnical study, it is our opinion that the proposed project is feasible from a geotechnical engineering standpoint. However, the conclusions and recommendations presented in this report should be incorporated in the design of the project to help minimize potential future soil and/or foundation related problems.

Floor (Foundation) and Wall Recommendations

The proposed sludge tank structure may be supported on a mat foundation placed on a prepared subgrade surface of the existing drain rock. Following excavation downward to the desired subgrade elevation within the drain rock, the entire drain rock subgrade (surface) should be compacted either by tamping with an excavator bucket or using a manually held "Wacker". This operation should be performed while the excavation is dewatered, and groundwater level is kept below the subgrade elevation. This operation should be performed under the continual observation of DAC. Once this operation is completed, a layer of filter fabric or other geotextile may be placed, if desired, atop the prepared subgrade to minimize infiltration of concrete during its placement. The estimated potential long-term total



settlement of the mat foundation under the recommended loads is estimated at about 1 to 3 inches, with ½ inch to 1½ inches of differential settlement across the structure.

The base of the structure, which will bear on the prepared existing drain rock layer, should be designed with allowable bearing pressures of 2,000 pounds per square foot (psf) for dead loads, 3,000 psf for dead plus live loads, and 4,000 psf for all loads including seismic. Resistance to lateral loads may be developed from friction between the bottom of the structure and the prepared drain rock based on a friction coefficient of 0.35 and from passive resistance within the drain rock equivalent to a fluid pressure of 450 pounds per cubic foot (pcf) acting against the vertical faces of foundations.

An active pressure equivalent to a fluid pressure of 45 pcf should be used in designing the walls. This value should also be used in design of the excavation shoring system. The buried portion of the structure should also be designed to resist full hydrostatic pressure (assuming groundwater level at surface grade) in addition to the above active earth pressures.

In calculating the lateral load on the walls, a seismic load (P_E) per unit length of the wall should also be included in calculating the lateral load. This seismic load, which should be applied at 0.6 of the height (0.6H) above the base of the wall, should be calculated using the equation $P_E = (3/8)\gamma H^2 k_h$, where P_E is the lateral load due to seismic forces applied at 0.6H above base of the wall (lb), γ is the unit weight of the soil, which is 160 pcf, H is the height of the retained soil (ft), and k_h is recommended to be taken as half of the value of peak ground acceleration. The peak ground acceleration (PGAM) for the site is equal to 0.504g, as determined from ASCE 7-16, Figure 22-7 and Equation 11.8-1.

The structure should be designed to resist buoyancy forces. It should be assumed that groundwater will, at times, be several feet higher than we observed in the field, due to high local tides and other factors, and will rise with future long-term rise in sea level.

Other Recommendations

The excavation will require dewatering during subgrade preparation and during placement of reinforcing steel and concrete. When designing and operating the dewatering system, the contractor should (1) consider height of groundwater level relative to the subgrade elevation and (2) take into account that the materials exposed in the excavation will be highly granular and porous and thus could admit large inflows of groundwater.

The sides of the excavation will require shoring in order to remain vertical and prevent collapse. In particular, the side (southeast side) where the raised steel structure is located immediately adjacent will need to be shored and monitored with extra caution to minimize



distress to the adjacent structure and its foundation(s). Excavation safety as stipulated by CALOSHA shall be observed throughout construction phase of the project.

Placement of backfill, if needed, should be performed in accordance with the recommendations presented in DAC's 2016 report.

Seismic Design Parameters

We have obtained site-specific spectral seismic design parameters in accordance with the 2016 edition of Standard ASCE-7. These design parameters, presented below in Table 1 and in Figure 2, are for use by the structural engineer in designing the basin structure for potential seismic shaking.

Table 1. Seismic design parameters.

Parameter	Value
S_S , for 0.2-second period	1.5 g
S_1 , for 1.0-second period	0.6 g
S_{MS} , for 0.2-second period	1.5 g
S_{M1} , for 1.0-second period	TBD per Section 11.4.8
S_{DS} , for 0.2-second period	1.0 g
S_{D1} , for 1.0-second period	TBD per Section 11.4.8

These values were obtained from a seismic design tool provided by the Structural Engineers Association of California, after providing Site Class D as input. We conclude that Class D is appropriate for the site, assuming an average N -value ranging between 15 and 50 in the upper 100 feet of the subsurface, which in turn is based on the blow counts obtained in the drain rock and weathered bedrock in Boring BG-16.

Additional Services

Additional geotechnical engineering services will be needed for design and construction of the project. These include plan review, and responses to plan-check comments, and construction observation by DAC.

Our firm should be accorded the opportunity to review the final plans and specifications to determine if the recommendations of this report and our applicable earlier reports have been implemented in those documents. Results of the review should be summarized in writing.



DAC Associates, Inc.
Supplemental Geotechnical Investigation
LGVSD Secondary Treatment Upgrades
300 Smith Ranch Road, San Rafael, CA

To a great degree, the performance of the site grading and improvement depend on construction procedures and quality. Therefore, we should provide on-site soil observations of the contractor’s procedures and the exposed soil, together with field and laboratory testing during excavating for foundations, preparation of subgrade under walkway slabs, placement of foundations, and placement and compaction of fill. These observations will allow us to check the contractor’s work for conformance with the intent of our recommendations and to observe any unanticipated soil conditions that could require modification of our recommendations. In addition, we would appreciate the opportunity to meet with the contractor before the start of grading to discuss the procedures and methods of construction. This can facilitate the performance of the construction operation and reduce possible misunderstandings and construction delays.

CLOSURE

Submittal of this letter report completes the current scope of our geotechnical study of the project.

We appreciate the opportunity of providing you with our engineering services and look forward to providing you with any additional geotechnical engineering services required for the project. If you have any questions or require additional information, please do not hesitate to contact us.

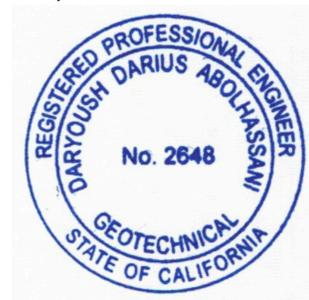
Sincerely,

DAC Associates, Inc.

Frank Groffie, P.G. C.E.G.
Principal Geologist
 PG 4930, CEG 1539



Darius Abolhassani, P.E., G.E.
Principal Engineer
 C58778, GE2648



Attachments:

- References
- Figure 1 — Site Plan
- Figure 2 — Seismic Design Parameters
- Appendix: Boring Log



DAC Associates, Inc.
Supplemental Geotechnical Investigation
LGVSD Secondary Treatment Upgrades
300 Smith Ranch Road, San Rafael, CA

References

DAC Associates, Inc. 2011, Geotechnical investigation report, Las Gallinas Valley Sanitation District Recycled Water Facility project, 300 Smith Ranch Road, San Rafael, California: DAC Associates, Inc., San Rafael, California, report for project 568-1011G, prepared for Aqua Engineering Inc., Bountiful, Utah.

DAC Associates, Inc. 2016, Geotechnical investigation report, secondary treatment upgrades project, Las Gallinas Valley Sanitation District (LGVSD), 300 Smith Ranch Road, San Rafael, CA 94903: DAC Associates, Inc., San Rafael, California, report for project 887-0715G, prepared for Aqua Engineering Inc., Bountiful, Utah.

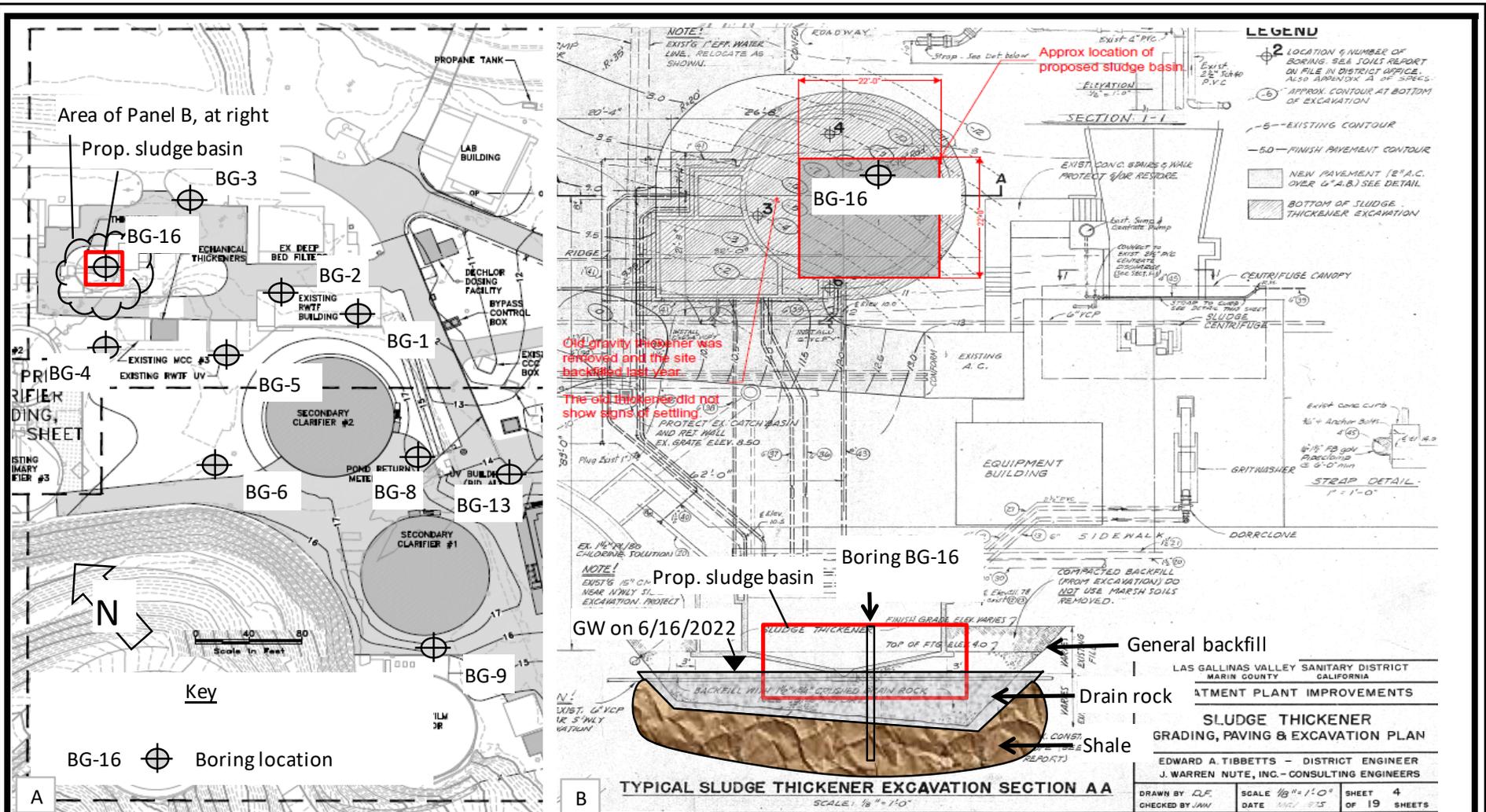


DAC Associates, Inc.
Supplemental Geotechnical Investigation
LGVSD Secondary Treatment Upgrades
300 Smith Ranch Road, San Rafael, CA

References

DAC Associates, Inc. 2011, Geotechnical investigation report, Las Gallinas Valley Sanitation District Recycled Water Facility project, 300 Smith Ranch Road, San Rafael, California: DAC Associates, Inc., San Rafael, California, report for project 568-1011G, prepared for Aqua Engineering Inc., Bountiful, Utah.

DAC Associates, Inc. 2016, Geotechnical investigation report, secondary treatment upgrades project, Las Gallinas Valley Sanitation District (LGVSD), 300 Smith Ranch Road, San Rafael, CA 94903: DAC Associates, Inc., San Rafael, California, report for project 887-0715G, prepared for Aqua Engineering Inc., Bountiful, Utah.



Boring BG-16 from this investigation. Borings BG-4 through 13 from DAC Associates (2016). Borings BG-1 through 3 from DAC Associates (2011).

Base: Panel A, General Grading Plan by Aqua Engineering, dated April 20, 2018. Panel B, Sheet 4 of LGVSD Treatment Plant Improvements, dated May 1975.

DAC101-2003



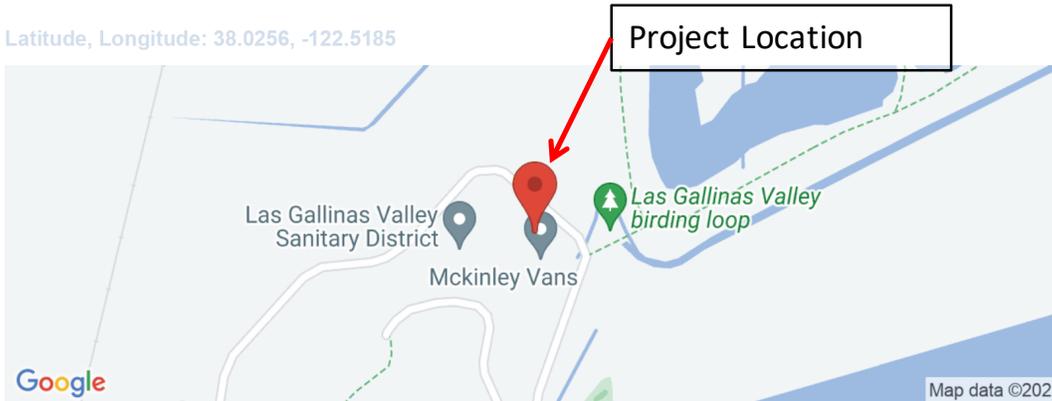
Site Plan
Sludge Basin
LGVSD Sanitary District
San Rafael, California

Report Date:	June 2022
Reviewed By:	DA
Proj. Manager:	DA
Job No.:	1313-3719C

Figure 2



Latitude, Longitude: 38.0256, -122.5185



Date	7/6/2022, 4:51:27 PM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Stiff Soil

Type	Value	Description
S _S	1.5	MCE _R ground motion. (for 0.2 second period)
S ₁	0.6	MCE _R ground motion. (for 1.0s period)
S _{MS}	1.5	Site-modified spectral acceleration value
S _{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S _{DS}	1	Numeric seismic design value at 0.2 second SA
S _{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

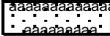
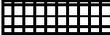
Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F _a	1	Site amplification factor at 0.2 second
F _v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.572	MCE _G peak ground acceleration
F _{PGA}	1.1	Site amplification factor at PGA
PGA _M	0.629	Site modified peak ground acceleration
T _L	12	Long-period transition period in seconds
SsRT	1.78	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.937	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.697	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.769	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.572	Factored deterministic acceleration value. (Peak Ground Acceleration)
C _{RS}	0.919	Mapped value of the risk coefficient at short periods
C _{R1}	0.907	Mapped value of the risk coefficient at a period of 1 s

Source: Structural Engineers Association of California, <https://seismicmaps.org/>

	Seismic Design Parameters	Report Date:	June 2022	Figure 2
	Sludge Basin LGVSD Sanitary District San Rafael, California	Reviewed By:	DA	
		Proj. Manager:	DA	
		Job No.:	1313-3719C	

Appendix: Boring Log

Material Symbols

 Topsoil  Fill  Asphalt  High-Plasticity Clay (CH)  Low-Plasticity Clay (CL)  Silt	 Loose Sand  Dense Sand  Gravel  Cobbles  Rock / Concrete  Colluvium
---	---

Sample Types

 Standard Penetration Test (SPT)  Modified California Sample (MC)	 Bulk Sample (Bag)  Shelby Tube Sample (Push)
--	--

Grain Sizes

##	U.S. Standard Series Sieve			Clear Square Sieve Openings			
	40	10	4	3/4"	3"	12"	
Silts and Clays	Sand			Gravel		Cobble	Boulder
	Fine	Medium	Coarse	Fine	Coarse		

Relative Density

Sands and Gravels	Blows/ Foot*
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

Consistency

Silts and Clays	Blows/Foot	Strength (tsf)**
Very Soft	0-2	0-1/4
Soft	2-4	1/4-1/2
Firm	4-8	1/2-1
Stiff	8-16	1-2
Very Stiff	16-32	2-4
Hard	Over 32	Over 4

* Number of blows for a 140-pound hammer falling 30 inches, driving a 2-inch O.D. (1-3/8" I.D.) split spoon sampler 12 inches into soil.

** Unconfined compressive strength.

Terminology & Abbreviations

W _n	Natural Moisture Content	LL	Liquid Limit	pp	Pocket Penetrometer
γ _d	Dry Density	PL	Plastic Limit	C _u	Undrained Shear Strength
O _c	Organic Content	PI	Plasticity Index	U _c	Unconfined Compressive Strength

	Key to Boring Logs	<u>Report Date:</u>	July 2022	Sheet A-0
	LGVSD treatment plant Secondary Treatment Upgrades San Rafael, California	<u>Reviewed By:</u>	DA	
		<u>Proj. Manager:</u>	DA	
		<u>Job No. 1313-3719C</u>		

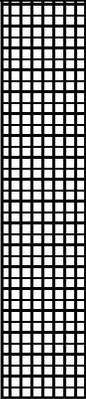
1313-3719C	Las Gallinas Valley Sanitary District wastewater treatment plant		Driller: Clear Heart
Date: June 16, 2022	Drill Rig: crawler-mounted rig	Hammer: standard, automatic	Borehole diam.: 7 in.
Groundwater: 8.1 ft bgs at 0830	Log of Boring BG-16 (page 1 of 2)		Logged by: FJG

Depth (ft)	Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)	
1					WELL-GRADED GRAVEL AND SAND (GW) — fill: gray, damp to moist, medium dense, 15% clay and silt, gravel is angular to rounded and up to 1½ in. diam., sandstone, shale, chert clasts, appearance of lower-quality aggregate road base	1	
2						2	
3						3	
4						4	
5	SPT	6				5	
6		9				6	
7		13				7	
8						▼ groundwater at 8.1 ft bgs at 0830 in existing hole 4 ft NW	8
9						POORLY GRADED GRAVEL (GP) — fill: gray, wet, very loose, 100% hard, angular sandstone or basalt fragments uniformly around 2 in. diam., appearance of drain rock, which is a crushed, screened quarry product	9
10	SPT	3				10	
11		2				11	
12		2				<10% sample recovery	12
13						13	
14						14	
15	SPT	3				loose	15
16		3				20% sample recovery	16
17		5				17	
18						18	
19						-----	19
20					SHALE — KJfsh: gray, wet, friable, weathered to very hard sandy clay in patches, intensely fractured; driller calls bedrock at 20 ft bgs	20	

Continued on next page.

	LGVSD treatment plant Secondary Treatment Upgrades San Rafael, California	Report Date:	July 2022	Sheet A-1
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	1313-3719C	

1313-3719C	Las Gallinas Valley Sanitary District wastewater treatment plant		Driller: Clear Heart
Date: June 16, 2022	Drill Rig: crawler-mounted rig	Hammer: standard, automatic	Borehole diam.: 7 in.
Groundwater: 8.1 ft bgs at 0830	Log of Boring BG-16 (page 2 of 2)		Logged by: FJG

Depth (ft)	Sample type	Blow counts	Test results	Graphic log	Material descriptions	Depth (ft)	
21	SPT	8 17 23			Continued from previous page SHALE — KJfsh, as described above	21	
22						22	
23						23	
24						24	
25						25	
26	SPT	11 19 37				26	
27						Bottom of boring at 26½ ft below ground surface. Groundwater as noted above. Hole backfilled with grout, bentonite chips, and cuttings under inspection from County env. health dept.	27
28							28
29							29
30							30
31							31
32							32
33							33
34							34
35							35
36							36
37							37
38							38
39							39
40							40

	LGVSD treatment plant Secondary Treatment Upgrades San Rafael, California	Report Date:	July 2022	Sheet A-2
		Reviewed By:	DA	
		Proj. Manager:	DA	
		Project No.:	1313-3719C	



July 17, 2018
 File: 1009.093altr.doc

Las Gallinas Valley Sanitary District
 300 Smith Ranch Road
 San Rafael, California 94903

Attn: Irene Huang, PE

Re: Results of Laboratory Testing
 Secondary Treatment Plant and Recycled Water Expansion
 San Rafael, California

Introduction

This letter presents the results of our laboratory testing for the Las Gallinas Valley Sanitary District's Secondary Treatment Plant Upgrade and Recycled Water Expansion project. The project site is located at the District's treatment plant at 300 Smith Ranch Road in San Rafael, California. The planned upgrades will include grading to raise the existing treatment plant access road. Potential fill sources for the planned grading include an existing stockpile containing dredged materials from Lower Miller Creek, as well as material obtained from the existing biofilters.

We understand the District would prefer to use the dredge spoils and biofilter materials as subbase for the access road grading and, as such, the materials will be required to conform to Caltrans criteria for aggregate subbase. The required gradation and minimum sand equivalent and R-value for various classes of aggregate subbase are included in Section 25 of the Caltrans Standard Specifications and are summarized in Tables 1 and 2 below. The purpose of our services is to perform laboratory testing of the various materials to evaluate whether the materials meet Caltrans criteria for aggregate subbase.

Table 1 – Aggregate Gradation for Aggregate Subbase

Sieve Size	Percentage Passing					
	Class 1		Class 2		Class 3	
	Operating Range	Contract Compliance	Operating Range	Contract Compliance	Operating Range	Contract Compliance
3"	100	100	100	100	100	100
2.5"	90 – 100	87 – 100	90 – 100	87 – 100	90 – 100	87 – 100
No. 4	35 – 70	30 – 75	40 – 90	35 – 95	50 – 100	45 – 100
No. 200	0 – 20	0 - 23	0 – 25	0 - 29	0 - 30	0 – 34

Table 2 – Aggregate Quality Characteristics for Aggregate Subbase

Quality Characteristic	Requirement					
	Class 1		Class 2		Class 3	
	Operating Range	Contract Compliance	Operating Range	Contract Compliance	Operating Range	Contract Compliance
Sand Equivalent	21	18	21	18	21	18
Resistance, (R-Value)	--	60	--	50	--	40

Sampling and Handling

We visited the site on June 13, 2018 to collect samples from the existing biofilters and stockpile of dredged materials. The location of the biofilters and stockpile area are shown on Figure 1. The biofilter material generally consists of subangular to subrounded, gravel- to cobble-sized fragments of rock. While the source of the material is not known, the rock appears to be derived from predominantly sandstone which classifies as “hard” to “very hard” per the USBR Field Manual⁽¹⁾.

We collected bulk samples of the biofilter material at various locations around the perimeter of the primary and secondary biofilters. We understand the biofilter material will be crushed during construction to reduce the particle size, and the material will be stockpiled onsite for reuse as fill. Therefore, in preparing the samples we crushed the rock with a hammer and allowed the material to air dry to simulate the anticipated field conditions during construction. The crushed samples from each biofilter were mixed to create a single composite sample and were transported to Analytical Sciences of Petaluma, California for environmental laboratory testing.

A total of ten bulk samples of the dredge spoils were also obtained from the stockpile located approximately a quarter-mile north of the treatment plant. The bulk samples were collected by excavating hand-dug test pits to depths of about two feet below the surface of the stockpile at the approximate locations shown on Figure 2. A series of three test pits were dug at each sample location with one located near the top, middle and base of the stockpile in general accordance with Caltrans Test Method 125⁽²⁾. The samples were sealed to prevent moisture loss and were transported to our laboratory. The bulk samples were visually classified and similar soil types were thoroughly mixed to create three composite samples for geotechnical laboratory testing. From our visual examination, samples 7, 9 and 10 included relatively higher percentages of Bay Mud and were mixed to create composite sample CS-1.

¹ US Department of the Interior, Bureau of Reclamation, “Engineering Geology Field Manual, Second Edition”, 1998.

² Caltrans, “Methods of Test for Sampling Highway Materials and Products Used in the Roadway Structural Sections (California Test 125), May 2014.

Geotechnical Laboratory Testing

Geotechnical laboratory tests were performed on the composite samples of dredge spoils to further classify the soils and estimate engineering properties. The following laboratory tests were conducted in general accordance with the test method cited:

- Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index, ASTM D4318
- Standard Test Method for Particle-Size Analysis of Soils, ASTM D422
- Sand Equivalent, California Test 217
- Resistance “R” Value by the Stabilometer, California Test 301

Testing for particle size, liquid limit, plastic limit and plasticity index was completed by Miller Pacific, whereas testing for R-value and sand equivalent was completed by Environmental Testing Services of Petaluma, California. The results of the geotechnical laboratory testing of dredge spoils are presented in Appendix A and are summarized in Table 3.

Table 3 – Summary of Dredge Spoils Laboratory Test Results

Composite Sample ID	Sample Locations ⁽¹⁾	Particle Size			Plasticity Index	Sand Equivalent	R-Value
		Fines (%)	Gravel (%)	Sand (%)			
CS-1	7, 9, 10	45.8	6.9	47.3	49	10	42
CS-2	1, 2, 6	39.1	15.8	45.1	17	8	49
CS-3	3, 4, 5, 8	43.8	15.8	40.4	15	7	47

Environmental Laboratory Testing

The composite sample of the biofilter material was tested to provide preliminary information pertaining to potential contamination. The analyses of the composite sample included the following tests:

- Volatile Hydrocarbons by GC/MS (EPA 8260B)
- Total Petroleum Hydrocarbons, Gasoline (EPA 8015B)
- Total Petroleum Hydrocarbons, Diesel & Motor Oil (EPA 8015B)
- CAM 17 Metals (EPA 6010B)
- Semi-Volatile Organics (SW8270C)

The results of the environmental laboratory testing are presented in Appendix B.

Conclusions

Based on the results of our geotechnical laboratory testing of the dredge spoils, composite sample CS-1 is classified as clayey sand per the Unified Soil Classification System, whereas composite samples CS-2 and CS-3 classify as clayey sand with gravel. The USCS group symbol for these soil types is "SC".

The testing indicates the dredge spoils do not meet the Caltrans criteria for aggregate subbase due to the relatively low sand equivalent values. Additionally, the materials are classified as "unsatisfactory soils" per Section 312000 of the project specifications since the USCS soil group classification is "SC". Therefore, the dredge spoil materials also do not appear to be acceptable for use as structural fill per the current specifications. We note that the criteria for structural fill in the specifications is relatively restrictive based on our experience with similar projects. The District should consult with the project Geotechnical Engineer to review the dredge spoils laboratory test results and determine whether there are specific applications for which the fill would be suitable (e.g. trench backfill, select fill for roadway construction, etc.)

Considering the biofilter material consists of relatively hard rock, we anticipate the material could be reused for aggregate subbase or structural fill provided it is crushed and processed to meet the respective gradation requirements. Alternatively, the crushed biofilter material could potentially be blended with the dredge spoils and graded to provide a more gravelly material which could be suitable for subbase and/or structural fill. Additional gradation testing of the crushed biofilter material should be performed during construction to confirm the material meets the appropriate gradation requirements.

Hazardous waste disposal is regulated at the Federal level by the Resource Conservation and Recovery Act and at the State level by Title 22 of the California Administrative Manual and the California Department of Toxic Substance Control. Additional regulations are locally imposed by the San Francisco Bay Area Regional Water Quality Control Board. The results of the environmental laboratory testing indicate the biofilter material is generally not considered hazardous toxic waste in accordance with federal and state regulations. While a number of the CAM 17 metals were detected, the test results indicate the levels are below the Title 22 specified total threshold limit concentration. Additionally, while a relatively low level of motor oil was detected in the composite sample, the level is below the San Francisco Bay Area Regional Water Quality Control Board's³ "Tier 1" Environmental Screening Levels for soil.

³ San Francisco Bay Regional Water Quality Control Board, "Environmental Screening Levels, Rev 3" (www.waterboards.ca.gov), February 2016.

Las Gallinas Valley Sanitary District
Page 5

July 17, 2018

We trust that this letter contains the information you require at this time. Please do not hesitate to contact us should there be any questions or should you wish to discuss the results of our testing.

Very truly yours,
MILLER PACIFIC ENGINEERING GROUP

REVIEWED BY



Rusty Arend
Geotechnical Engineer No. 3031
(Expires 6/30/19)

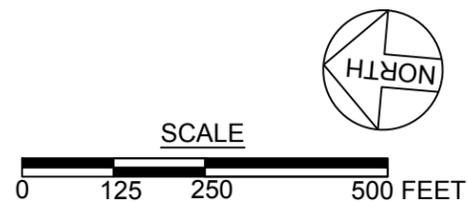
Scott Stephens
Geotechnical Engineer No. 2398
(Expires 6/30/19)

Attachments: Figure 1, Appendices A and B



LEGEND:

 APPROX. LOCATION OF BULK SAMPLE

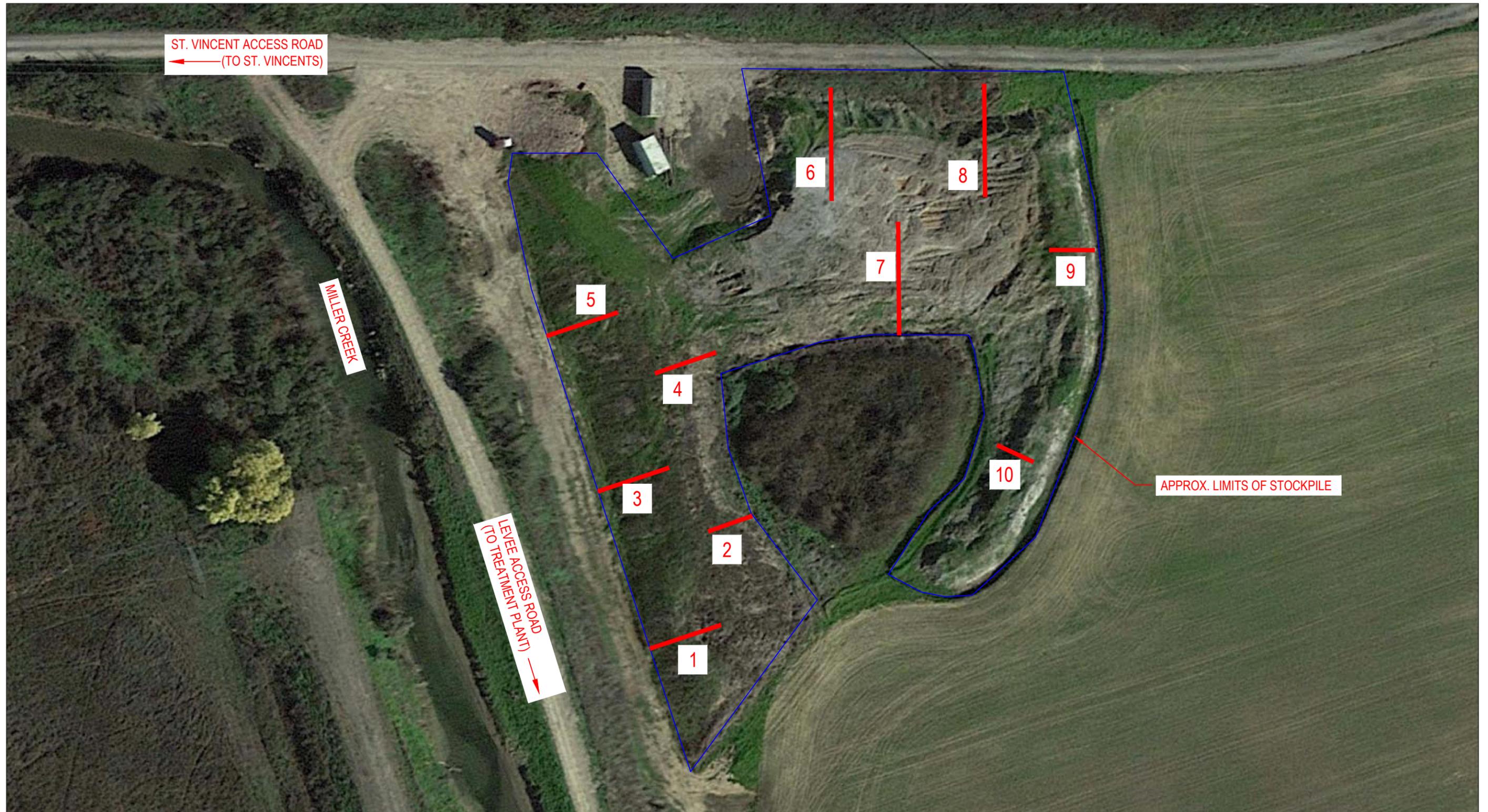


MPEG
MILLER PACIFIC
ENGINEERING GROUP

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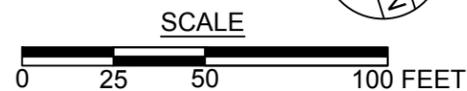
504 Redwood Blvd.
 Suite 220
 Novato, CA 94947
 T 415 / 382-3444
 F 415 / 382-3450
 www.millerpac.com

STOCKPILE & BIOFILTER LOCATIONS	
LGVSD Secondary Treatment Plant Upgrades San Rafael, California	
Project No. 1009.093	Date: 7/13/2018
Drawn: RCA	1 FIGURE
Checked: SAS	
Page 168 of 199	



LEGEND:

 APPROX. LOCATION OF BULK SAMPLE



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 FILE: 1009.093 Sampling Locations.dwg

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STOCKPILE SAMPLING LOCATIONS

LGVSD Secondary Treatment
 Plant Upgrades
 San Rafael, California

Project No. 1009.093 Date: 7/13/2018

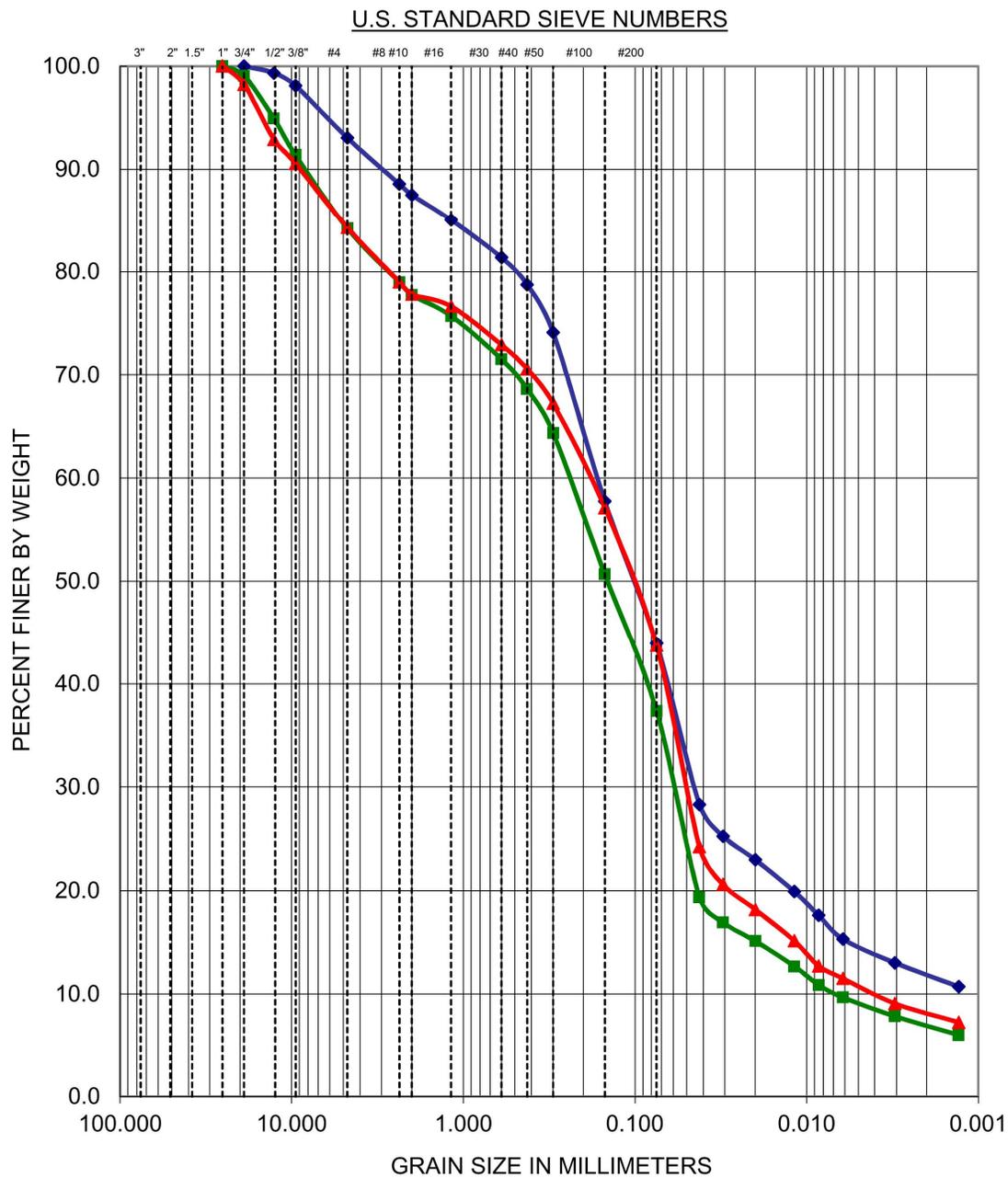
Drawn: RCA
 Checked: SAS

2

FIGURE
 Page 166 of 199

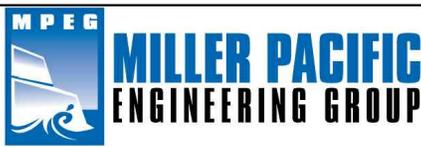


APPENDIX A
GEOTECHNICAL LABORATORY TEST RESULTS



SYMBOL	SAMPLE SOURCE	CLASSIFICATION
—◆—	CS-1 (Bulk Samples 7, 9, & 10)	Clayey SAND (SC)
—■—	CS-2 (Samples 1, 2, & 6)	Clayey SAND with Gravel (SC)
—▲—	CS-3 (Samples 3, 4, 5, & 8)	Clayey SAND with Gravel (SC)

Test: ASTM D-422



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SIEVE ANALYSES

LGVSD Secondary Treatment
 Plant Upgrades
 San Rafael, California

Project No. 1009.093 Date: 7/13/2016

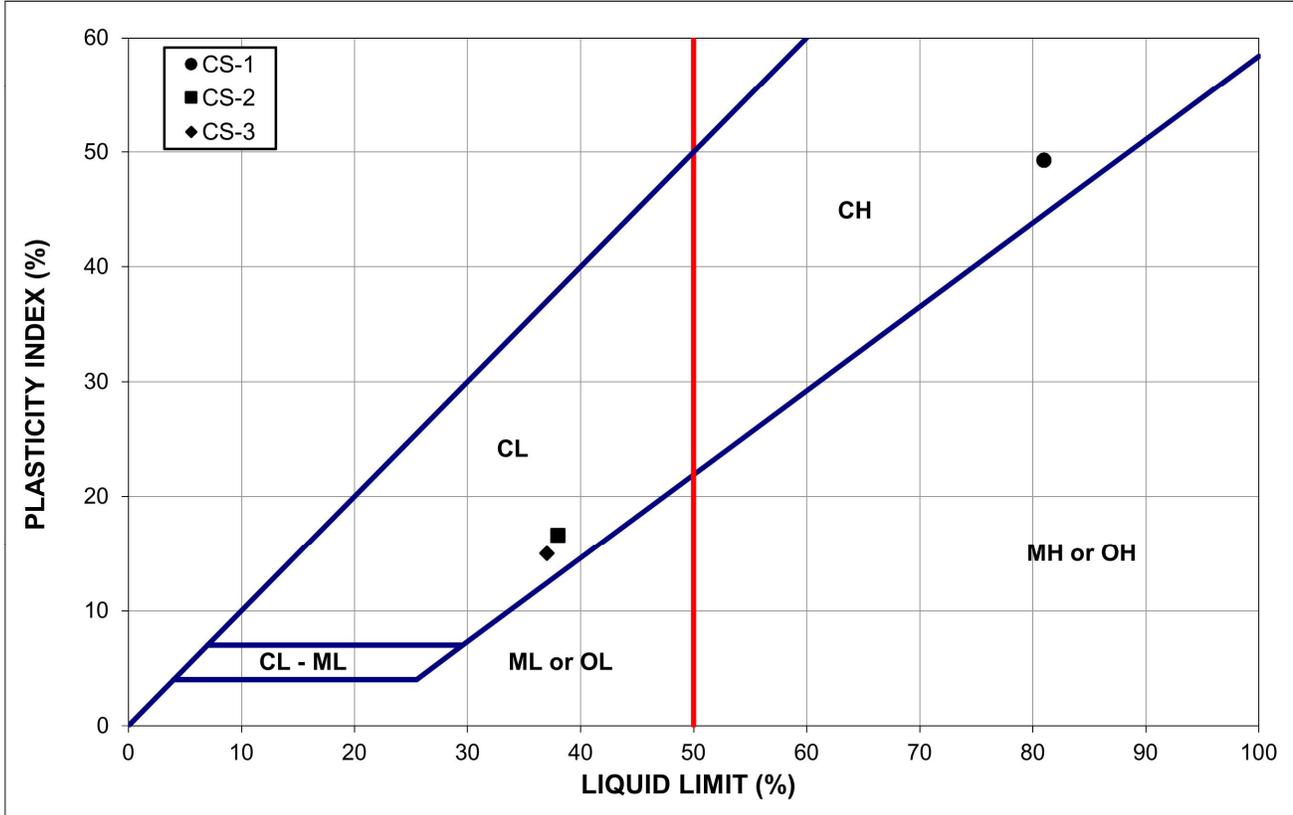
Drawn RCA
 Checked

A-1

FIGURE
 Page 758 of 899

MILLER PACIFIC ENGINEERING GROUP

ATTERBERG LIMITS TEST (ASTM D 4318)



Sample	Classification	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
CS-1	Clayey SAND (SC) brown	81	32	49
CS-2	Clayey SAND with Gravel (SC) light brown	38	21	17
CS-3	Clayey SAND with Gravel (SC) light brown	37	22	15

PI = 0-3: Non-Plastic
 PI = 3-15: Slightly Plastic
 PI = 15-30: Medium Plasticity
 PI = >30: High Plasticity



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ATTERBERG LIMITS

LGVSD Secondary Treatment
 Plant Upgrades
 San Rafael, California

Project No. 1009.093 Date: 7/13/2016

Drawn RCA
 Checked

A-2

FIGURE
 Page 759 of 899



ETS

Environmental Technical Services

- Soil, Water & Air Testing & Monitoring
- Analytical Labs
- Technical Support

975 Transport Way, Suite 2
 Petaluma, CA 94954
 (707) 778-9605/FAX 778-9612
 e-mail: entech@pacbell.net

**Serving people and the environment
 so that both benefit.**

DURABILITY, SAND EQUIVALENT and R-VALUE REPORT

To: Rusty Arend
 Miller Pacific Engin. Group
 504 Redwood Blvd., Suite 220
 Novato, CA 94947

Date: July 10, 2018

Lab #: 07808-1 thru 078087-3

Received: June 22, 2018

Sample Proc: S, Santos

Samples of: Silty Clays (w
 some sand & gravel)

Job Supervisor: D. Jacobson

Job Director: G.S. Conrad, Ph.D.

Job No.: 1009.093

Sample ID(s): CS-1, CS-1, and CS-3

Site Location: Las Gallinas Valley Sanitary Dist, 300 Smith Ranch Rd, San Rafael, Calif.

RESULTS

SAMPLE ID	SAND EQUIVALENT	DURABILITY TEST RESULTS			R-Value
		FINES DURABILITY	COARSE DURABILITY	DURABILITY INDEX	
CS-1	10	--	--	--	42
	8.7, 9.6, 9.4	Expansion Pressure (@ 300 psi Exud. Pres. @ 300 psf) →			345
CS-2	8	--	--	--	49
	8.0, 7.9, 8.1	Expansion Pressure (@ 300 psi Exud. Pres. @ 300 psf) →			140
CS-3	7	--	--	--	47
	6.9, 6.6, 7.1	Expansion Pressure (@ 300 psi Exud. Pres. @ 300 psf) →			97

COMMENTS

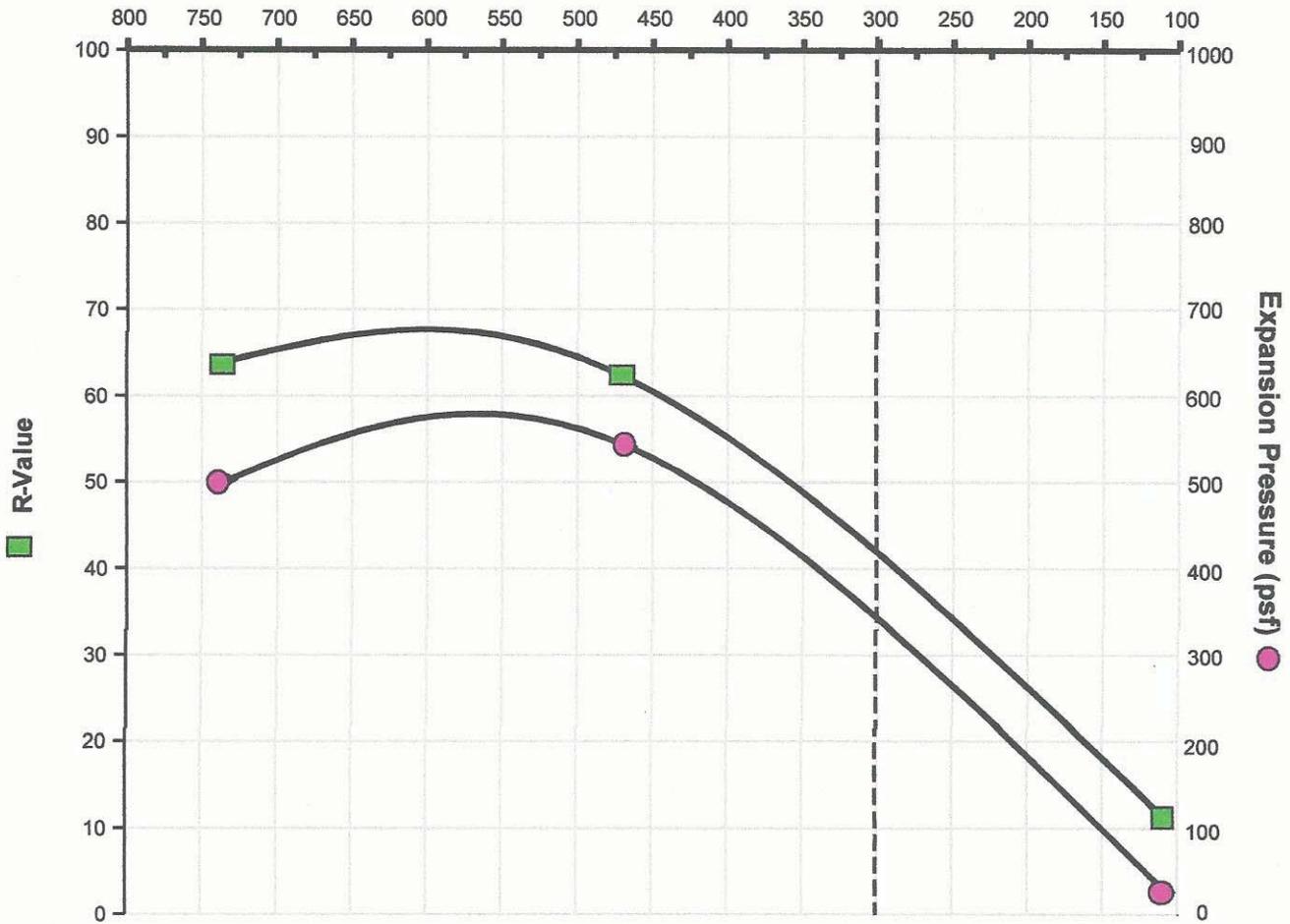
These procedures determine degree of hardness, granularity and strength of submitted materials. These materials all have fairly low SE values being at 10 or less. They do possess some sand and even gravel, but appear to be mostly comprised of silts and clays. While silts probably dominate proportionally, clays may dominate in terms of their physio-mechanical properties. The R-Values of the these native soil materials are all in the moderate range of 40-50, and they exhibit high to very high exudation pressures.

NOTES:

Tests are done in accordance with Cal Trans methodologies as follows: Coarse & Fines Durability/Durability Index - Cal Test 229; Sand Equivalent (three trials average) - Cal Test 217; R-Value - Cal Test 301 (=ASTM D2844).

R-VALUE TEST REPORT

Exudation Pressure (psi)

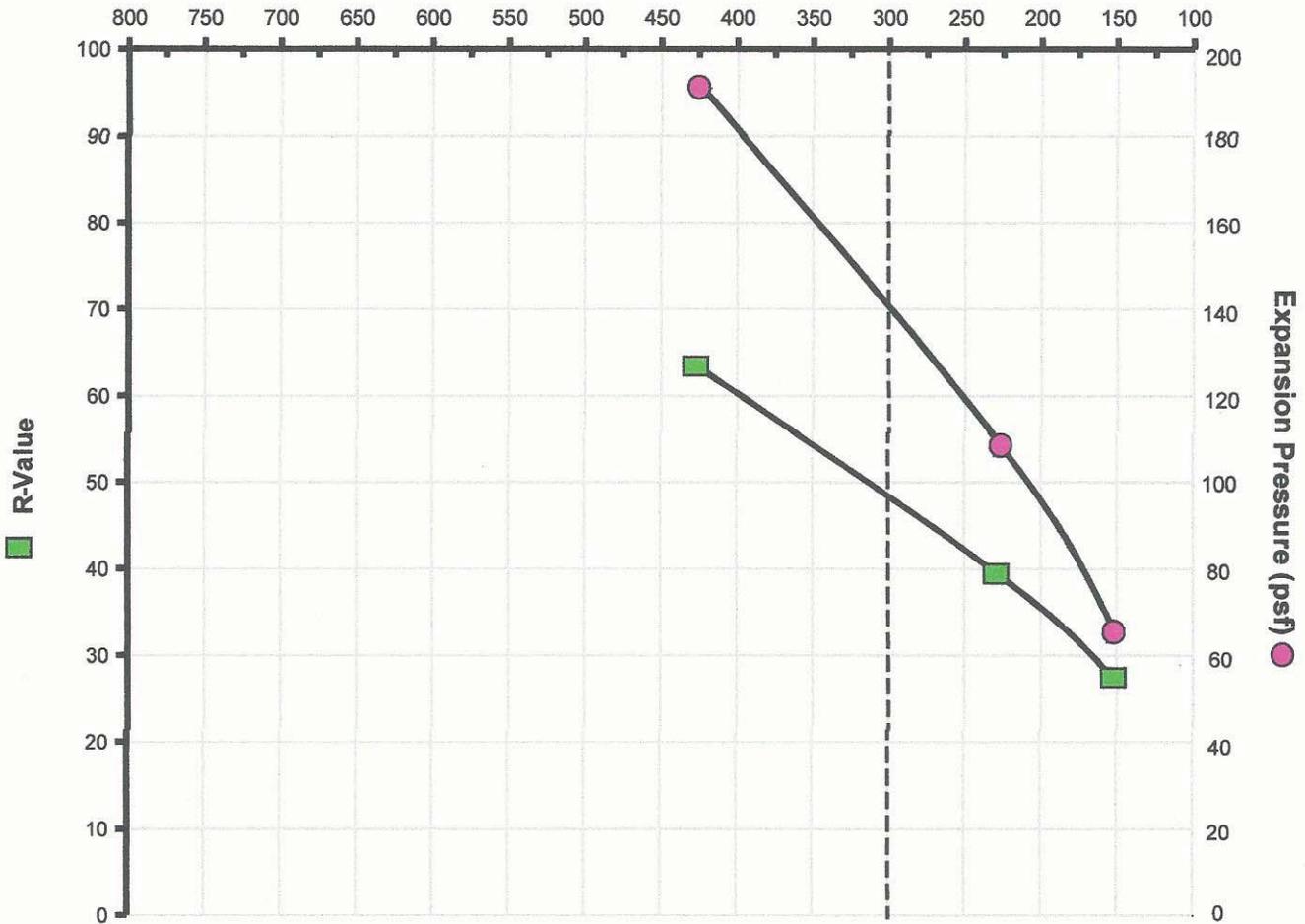


Test Data & Conditions for Each Point		Wet Weight, gm: 544.6, 499.6, 563.1			Total Weight, gm: 3148.0, 3149.0, 3179.0					
		Dry Weight, gm: 440.7, 438.1, 497.6			Mold Weight, gm: 2182.0, 2181.0, 2165.0					
		Tare Weight, gm: 115.3, 116.0, 115.4			Exudate Load (lbs.): 1340, 5850, 9200					
Test Point	Moisture %	Density pcf	Sample Ht. in.	Lateral Press. @ 2000 lbs	Compaction Pressure	Expansion Pressures	Exudation Pressure	R Value	R-Value (corrected)	
1	31.9	88.4	2.51	132	105 psi	26 psf	107 psi	11	11	
2	19.1	105.3	2.34	40	320 psi	541 psf	466 psi	67	62	
3	17.1	108.0	2.43	41	320 psi	502 psf	732 psi	67	64	
Sample No.:		07808-1		Sample Description:		Lt. Olive Brown Silty Clay		Exp. Pres. @ 300 psi		345
								R Value @ 300 psi Exudate Pressure		42

Environmental Technical Services	R-VALUE TEST		Sample Source:	Plate: 1
	Client: Miller Pacific Engineering Group 504 Redwood Blvd., #220, Novato, CA		native soil	
	Location/Job: Las Gallinas Valley Sanitary Dist. Project No.: 1009.093		Sample ID: CS-1	
		Date: 07/10/2018		

R-VALUE TEST REPORT

Exudation Pressure (psi)

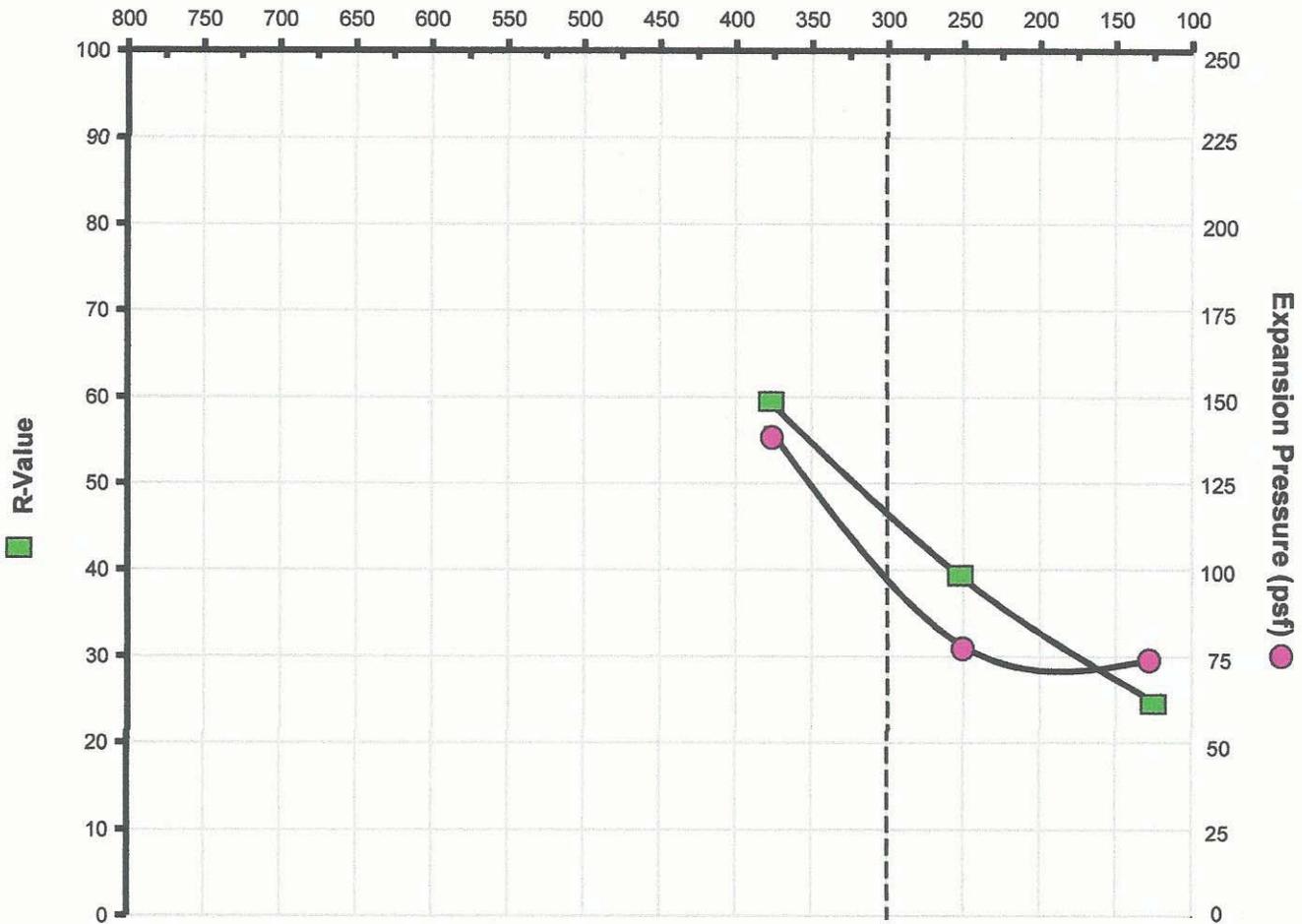


Test Data & Conditions for Each Point		Wet Weight, gm: 683.8, 652.0, 390.7			Total Weight, gm: 3216.0, 3200.0, 3294.0			Dry Weight, gm: 621.0, 586.0, 621.9			Mold Weight, gm: 2151.0, 2083.0, 2186.0		
		Tare Weight, gm: 193.7, 191.3, 188.5			Exudate Load (lbs.): 5320, 1900, 2830								
Test Point	Moisture %	Density pcf	Sample Ht. in.	Lateral Press. @ 2000 lbs	Compaction Pressure	Expansion Pressures	Exudation Pressure	R Value	R-Value (corrected)				
1	14.7	116.3	2.42	37	300 psi	191 psf	423 psi	66	63				
2	16.7	111.2	2.61	100	175 psi	65 psf	151 psi	25	27				
3	15.9	112.8	2.57	75	300 psi	108 psf	225 psi	37	39				
Sample No.:		07808-2		Sample Description:		Lt. Yellowish Brown Silty Clay		Exp.Pres. @ 300 psi		140			
								R Value @ 300 psi Exudate Pressure		49			

Environmental Technical Services	R-VALUE TEST			Sample Type:	Plate: 2
	Client: Miller Pacific Engineering Group			native soil	
	Location/Job: 504 Redwood Blvd., #220, Novato, CA			Sample ID:	
	Project No.: 1009.093			CS-2	
			Date: 07/10/2018		

R-VALUE TEST REPORT

Exudation Pressure (psi)



Test Data & Conditions for Each Point		Wet Weight, gm: 680.6, 715.8, 648.2			Total Weight, gm: 3166.0, 3256.0, 3241.0					
		Dry Weight, gm: 623.2, 644.9, 594.2			Mold Weight, gm: 2083.0, 2188.0, 2183.0					
		Tare Weight, gm: 197.0, 197.1, 191.0			Exudate Load (lbs.): 3140, 1590, 4710					
Test Point	Moisture %	Density pcf	Sample Ht. in.	Lateral Press. @ 2000 lbs	Compaction Pressure	Expansion Pressures	Exudation Pressure	R Value	R-Value (corrected)	
1	13.5	117.2	2.47	78	275 psi	74 psf	250 psi	39	39	
2	15.8	112.3	2.49	102	195 psi	78 psf	127 psi	25	25	
3	13.4	118.4	2.39	44	320 psi	139 psf	375 psi	62	59	
Sample No.:		07808-3		Sample Description:		Lt. Olive Brown Silty Clay		Exp.Pres. @ 300 psi		97
								R Value @ 300 psi Exudate Pressure		47

Environmental Technical Services	R-VALUE TEST			Sample Type:	Plate: 3
	Client: Miller Pacific Engineering Group 504 Redwood Blvd., #220, Novato, CA			native soil	
	Location/Job: Las Gallinas Valley Sanitary Dist. Project No.: 1009.093			Sample ID: CS-3	
			Date: 07/10/2018		



APPENDIX B
ENVIRONMENTAL LABORATORY TEST RESULTS



Report Date: July 12, 2018

Laboratory Report

Rusty Arend
Miller Pacific Engineering - Novato
504 Redwood Blvd., Suite 220
Novato, CA 94947

Project Name: **LBUSD** **1009.093 - Biofilter Testing**
Lab Project Number: **8070903**

This 13 page report of analytical data has been reviewed and approved for release.

Michele Peters
Laboratory Director



Volatile Hydrocarbons by GC/MS

Lab#	Sample ID	Compound Name	Result (µg/kg)		RDL (µg/kg)
8070903-01	BF - 1/2	Dichlorodifluoromethane (F-12)	ND	HT2	2.0
		Chloromethane	ND		2.0
		Vinyl chloride	ND		2.0
		Chloroethane (CE)	ND		2.0
		Bromomethane	ND		2.0
		Trichlorofluoromethane (F-11)	ND		2.0
		Trichlorotrifluoroethane (F-113)	ND		2.0
		1,1-Dichloroethene (1,1-DCE)	ND		2.0
		Methylene chloride	ND		2.0
		trans-1,2-Dichloroethene	ND		2.0
		1,1-Dichloroethane (1,1-DCA)	ND		2.0
		cis-1,2-Dichloroethene (c1,2-DCE)	ND		2.0
		2,2-Dichloropropane	ND		2.0
		Chloroform (THM1)	ND		2.0
		Bromochloromethane	ND		2.0
		1,1,1-Trichloroethane (TCA)	ND		2.0
		1,2-Dichloroethane (EDC)	ND		2.0
		1,1-Dichloropropene	ND		2.0
		Carbon tetrachloride	ND		2.0
		Benzene	ND		2.0
		Trichloroethene (TCE)	ND		2.0
		1,2-Dichloropropane (DCP)	ND		2.0
		Dibromomethane	ND		2.0
		Bromodichloromethane (THM2)	ND		2.0
		cis-1,3-Dichloropropene	ND		2.0
		Toluene	ND		2.0
		1,1,2-Trichloroethane	ND		2.0
		1,3-Dichloropropane	ND		2.0
		Dibromochloromethane (THM3)	ND		2.0
		Tetrachloroethene (PCE)	ND		2.0
		1,2-Dibromoethane (EDB)	ND		2.0
		Chlorobenzene	ND		2.0
		1,1,1,2-Tetrachloroethane	ND		2.0
		Ethylbenzene	ND		2.0
		m,p-Xylene	ND		2.0
		Styrene	ND		2.0
		o-Xylene	ND		2.0
		Bromoform (THM4)	ND		2.0
		1,1,2,2-Tetrachloroethane	ND		2.0
		Isopropylbenzene	ND		2.0
		1,2,3-Trichloropropane	ND		2.0
		Bromobenzene	ND		2.0
		n-Propyl Benzene	ND		2.0
		2-Chlorotoluene	ND		2.0
		4-Chlorotoluene	ND		2.0
		1,3,5-Trimethylbenzene	ND		2.0
		tert-Butylbenzene	ND		2.0
		1,2,4-Trimethylbenzene	ND		2.0
		sec-Butylbenzene	ND		2.0



Volatile Hydrocarbons by GC/MS

Lab#	Sample ID	Compound Name	Result (µg/kg)	RDL (µg/kg)
8070903-01	BF - 1/2	1,3-Dichlorobenzene	ND	2.0
		1,4-Dichlorobenzene	ND	2.0
		1,2-Dichlorobenzene	ND	2.0
		p-Isopropyltoluene	ND	2.0
		n-Butylbenzene	ND	2.0
		1,2-Dibromo-3-chloropropane	ND	2.0
		1,2,4-Trichlorobenzene	ND	2.0
		Naphthalene	ND	2.0
		Hexachlorobutadiene	ND	2.0
		1,2,3-Trichlorobenzene	ND	2.0
		Tertiary Butyl Alcohol (TBA)	ND	25
		Methyl tert-Butyl Ether (MTBE)	ND	2.0
		Di-isopropyl Ether (DIPE)	ND	2.0
		Ethyl tert-Butyl Ether (ETBE)	ND	2.0
		Tert-Amyl Methyl Ether (TAME)	ND	2.0
Surrogates	Result (µg/kg)	% Recovery	Acceptance Range (%)	
Dibromofluoromethane	42.8	89	70-130	
Toluene-d8	47.4	98	70-130	
4-Bromofluorobenzene	50.8	105	70-130	

Date Sampled: 06/13/18	Date Analyzed: 07/09/18	QC Batch: B017838
Date Received: 07/09/18	Method: EPA 8260B	

TPH Gasoline

Lab#	Sample ID	Compound Name	Result (mg/kg)	RDL (mg/kg)
8070903-01	BF - 1/2	Gasoline	ND HT2	1.0

Date Sampled: 06/13/18	Date Analyzed: 07/09/18	QC Batch: B017836
Date Received: 07/09/18	Method: EPA 8015B	



TPH Diesel & Motor Oil

Lab#	Sample ID	Compound Name	Result (mg/kg)		RDL (mg/kg)
8070903-01	BF - 1/2	Diesel	ND	HT2	5.0
		Motor Oil	76		50

Date Sampled:	06/13/18	Date Analyzed:	07/10/18	QC Batch:	B017842
Date Received:	07/09/18	Method:	EPA 8015B		

CAM Metals

Lab#	Sample ID	Compound Name	Result (mg/kg)		RDL (mg/kg)
8070903-01	BF - 1/2	Antimony (Sb)	ND		5.0
		Arsenic (As)	2.0		1.5
		Barium (Ba)	33		2.0
		Beryllium (Be)	ND		0.50
		Cadmium (Cd)	ND		0.50
		Chromium (Cr)	24		1.5
		Cobalt (Co)	7.1		1.5
		Copper (Cu)	40		2.0
		Lead (Pb)	3.6		3.0
		Molybdenum (Mo)	ND		1.0
		Nickel (Ni)	29		2.0
		Selenium (Se)	ND		5.0
		Silver (Ag)	ND		1.0
		Thallium (Tl)	ND		5.0
		Vanadium (V)	18		2.0
		Zinc (Zn)	38		5.0

Date Sampled:	06/13/18	Date Analyzed:	07/11/18	QC Batch:	B017830
Date Received:	07/09/18	Method:	EPA 6010B		

Mercury

Lab#	Sample ID	Compound Name	Result (mg/kg)		RDL (mg/kg)
8070903-01	BF - 1/2	Mercury (Hg)	ND	HT2	0.10

Date Sampled:	06/13/18	Date Analyzed:	07/11/18	QC Batch:	B017785
Date Received:	07/09/18	Method:	EPA 7471A		



Notes and Definitions

HT2	The sample was received and therefore analyzed after the recommended holding time.
RDL	Reporting Detection Limit
ND	Analyte NOT DETECTED at or above the reporting detection limit (RDL)
RPD	Relative Percent Difference
NR	Not Reported



Glossary of Terms & Qualifier Definitions

Client: Analytical Sciences
Project: 8070903; Biofilter Testing
WorkOrder: 1807338

Glossary Abbreviation

%D	Serial Dilution Percent Difference
95% Interval	95% Confident Interval
DF	Dilution Factor
DI WET	(DISTLC) Waste Extraction Test using DI water
DISS	Dissolved (direct analysis of 0.45 µm filtered and acidified water sample)
DLT	Dilution Test (Serial Dilution)
DUP	Duplicate
EDL	Estimated Detection Limit
ERS	External reference sample. Second source calibration verification.
ITEF	International Toxicity Equivalence Factor
LCS	Laboratory Control Sample
MB	Method Blank
MB % Rec	% Recovery of Surrogate in Method Blank, if applicable
MDL	Method Detection Limit
ML	Minimum Level of Quantitation
MS	Matrix Spike
MSD	Matrix Spike Duplicate
N/A	Not Applicable
ND	Not detected at or above the indicated MDL or RL
NR	Data Not Reported due to matrix interference or insufficient sample amount.
PDS	Post Digestion Spike
PDSD	Post Digestion Spike Duplicate
PF	Prep Factor
RD	Relative Difference
RL	Reporting Limit (The RL is the lowest calibration standard in a multipoint calibration.)
RPD	Relative Percent Deviation
RRT	Relative Retention Time
SPK Val	Spike Value
SPKRef Val	Spike Reference Value
SPLP	Synthetic Precipitation Leachate Procedure
ST	Sorbent Tube
TCLP	Toxicity Characteristic Leachate Procedure
TEQ	Toxicity Equivalents
WET (STLC)	Waste Extraction Test (Soluble Threshold Limit Concentration)



Glossary of Terms & Qualifier Definitions

Client: Analytical Sciences
Project: 8070903; Biofilter Testing
WorkOrder: 1807338

Analytical Qualifiers

H Samples were analyzed out of holding time.
a4 Reporting limits raised due to the sample's matrix prohibiting a full volume extraction.

Quality Control Qualifiers

F2 LCS/LCSD recovery and/or RPD is out of acceptance criteria.



Analytical Report

Client: Analytical Sciences
Date Received: 7/10/18 11:00
Date Prepared: 7/10/18
Project: 8070903; Biofilter Testing

WorkOrder: 1807338
Extraction Method: SW3550B
Analytical Method: SW8270C
Unit: mg/Kg

Semi-Volatile Organics

Client ID	Lab ID	Matrix	Date Collected	Instrument	Batch ID
BF-½	1807338-001A	Soil	06/13/2018 11:00	GC21 07101837.D	161168

Analytes	Result	Qualifiers	RL	DF	Date Analyzed
Acenaphthene	ND	H	2.0	1	07/11/2018 01:56
Acenaphthylene	ND	H	2.0	1	07/11/2018 01:56
Acetochlor	ND	H	2.0	1	07/11/2018 01:56
Anthracene	ND	H	2.0	1	07/11/2018 01:56
Benzidine	ND	H	10	1	07/11/2018 01:56
Benzo (a) anthracene	ND	H	2.0	1	07/11/2018 01:56
Benzo (a) pyrene	ND	H	2.0	1	07/11/2018 01:56
Benzo (b) fluoranthene	ND	H	2.0	1	07/11/2018 01:56
Benzo (g,h,i) perylene	ND	H	2.0	1	07/11/2018 01:56
Benzo (k) fluoranthene	ND	H	2.0	1	07/11/2018 01:56
Benzyl Alcohol	ND	H	10	1	07/11/2018 01:56
1,1-Biphenyl	ND	H	2.0	1	07/11/2018 01:56
Bis (2-chloroethoxy) Methane	ND	H	2.0	1	07/11/2018 01:56
Bis (2-chloroethyl) Ether	ND	H	2.0	1	07/11/2018 01:56
Bis (2-chloroisopropyl) Ether	ND	H	2.0	1	07/11/2018 01:56
Bis (2-ethylhexyl) Adipate	ND	H	2.0	1	07/11/2018 01:56
Bis (2-ethylhexyl) Phthalate	ND	H	2.0	1	07/11/2018 01:56
4-Bromophenyl Phenyl Ether	ND	H	2.0	1	07/11/2018 01:56
Butylbenzyl Phthalate	ND	H	2.0	1	07/11/2018 01:56
4-Chloroaniline	ND	H	4.0	1	07/11/2018 01:56
4-Chloro-3-methylphenol	ND	H	2.0	1	07/11/2018 01:56
2-Chloronaphthalene	ND	H	2.0	1	07/11/2018 01:56
2-Chlorophenol	ND	H	2.0	1	07/11/2018 01:56
4-Chlorophenyl Phenyl Ether	ND	H	2.0	1	07/11/2018 01:56
Chrysene	ND	H	2.0	1	07/11/2018 01:56
Dibenzo (a,h) anthracene	ND	H	2.0	1	07/11/2018 01:56
Dibenzofuran	ND	H	2.0	1	07/11/2018 01:56
Di-n-butyl Phthalate	ND	H	2.0	1	07/11/2018 01:56
1,2-Dichlorobenzene	ND	H	2.0	1	07/11/2018 01:56
1,3-Dichlorobenzene	ND	H	2.0	1	07/11/2018 01:56
1,4-Dichlorobenzene	ND	H	2.0	1	07/11/2018 01:56
3,3-Dichlorobenzidine	ND	H	4.0	1	07/11/2018 01:56
2,4-Dichlorophenol	ND	H	2.0	1	07/11/2018 01:56
Diethyl Phthalate	ND	H	2.0	1	07/11/2018 01:56
2,4-Dimethylphenol	ND	H	2.0	1	07/11/2018 01:56
Dimethyl Phthalate	ND	H	2.0	1	07/11/2018 01:56
4,6-Dinitro-2-methylphenol	ND	H	10	1	07/11/2018 01:56

(Cont.)



Analytical Report

Client: Analytical Sciences
Date Received: 7/10/18 11:00
Date Prepared: 7/10/18
Project: 8070903; Biofilter Testing

WorkOrder: 1807338
Extraction Method: SW3550B
Analytical Method: SW8270C
Unit: mg/Kg

Semi-Volatile Organics

Client ID	Lab ID	Matrix	Date Collected	Instrument	Batch ID
BF-½	1807338-001A	Soil	06/13/2018 11:00	GC21 07101837.D	161168
Analytes	Result	Qualifiers	RL	DF	Date Analyzed
2,4-Dinitrophenol	ND	H	50	1	07/11/2018 01:56
2,4-Dinitrotoluene	ND	H	2.0	1	07/11/2018 01:56
2,6-Dinitrotoluene	ND	H	2.0	1	07/11/2018 01:56
Di-n-octyl Phthalate	ND	H	4.0	1	07/11/2018 01:56
1,2-Diphenylhydrazine	ND	H	2.0	1	07/11/2018 01:56
Fluoranthene	ND	H	2.0	1	07/11/2018 01:56
Fluorene	ND	H	2.0	1	07/11/2018 01:56
Hexachlorobenzene	ND	H	2.0	1	07/11/2018 01:56
Hexachlorobutadiene	ND	H	2.0	1	07/11/2018 01:56
Hexachlorocyclopentadiene	ND	H	10	1	07/11/2018 01:56
Hexachloroethane	ND	H	2.0	1	07/11/2018 01:56
Indeno (1,2,3-cd) pyrene	ND	H	2.0	1	07/11/2018 01:56
Isophorone	ND	H	2.0	1	07/11/2018 01:56
2-Methylnaphthalene	ND	H	2.0	1	07/11/2018 01:56
2-Methylphenol (o-Cresol)	ND	H	2.0	1	07/11/2018 01:56
3 & 4-Methylphenol (m,p-Cresol)	ND	H	2.0	1	07/11/2018 01:56
Naphthalene	ND	H	2.0	1	07/11/2018 01:56
2-Nitroaniline	ND	H	10	1	07/11/2018 01:56
3-Nitroaniline	ND	H	10	1	07/11/2018 01:56
4-Nitroaniline	ND	H	10	1	07/11/2018 01:56
Nitrobenzene	ND	H	2.0	1	07/11/2018 01:56
2-Nitrophenol	ND	H	10	1	07/11/2018 01:56
4-Nitrophenol	ND	H	10	1	07/11/2018 01:56
N-Nitrosodiphenylamine	ND	H	2.0	1	07/11/2018 01:56
N-Nitrosodi-n-propylamine	ND	H	2.0	1	07/11/2018 01:56
Pentachlorophenol	ND	H	10	1	07/11/2018 01:56
Phenanthrene	ND	H	2.0	1	07/11/2018 01:56
Phenol	ND	H	2.0	1	07/11/2018 01:56
Pyrene	ND	H	2.0	1	07/11/2018 01:56
Pyridine	ND	H	2.0	1	07/11/2018 01:56
1,2,4-Trichlorobenzene	ND	H	2.0	1	07/11/2018 01:56
2,4,5-Trichlorophenol	ND	H	2.0	1	07/11/2018 01:56
2,4,6-Trichlorophenol	ND	H	2.0	1	07/11/2018 01:56

(Cont.)



Analytical Report

Client: Analytical Sciences
Date Received: 7/10/18 11:00
Date Prepared: 7/10/18
Project: 8070903; Biofilter Testing

WorkOrder: 1807338
Extraction Method: SW3550B
Analytical Method: SW8270C
Unit: mg/Kg

Semi-Volatile Organics

Client ID	Lab ID	Matrix	Date Collected	Instrument	Batch ID
BF-½	1807338-001A	Soil	06/13/2018 11:00	GC21 07101837.D	161168

Analytes	Result	Qualifiers	RL	DF	Date Analyzed
Surrogates	REC (%)	Qualifiers	Limits		
2-Fluorophenol	115	H	30-130		07/11/2018 01:56
Phenol-d5	97	H	30-130		07/11/2018 01:56
Nitrobenzene-d5	102	H	30-130		07/11/2018 01:56
2-Fluorobiphenyl	80	H	30-130		07/11/2018 01:56
2,4,6-Tribromophenol	103	H	16-130		07/11/2018 01:56
4-Terphenyl-d14	81	H	30-130		07/11/2018 01:56

Analyst(s): REB

Analytical Comments: a4

July 17, 2018
File: 1009.094altr.doc

Las Gallinas Valley Sanitary District
300 Smith Ranch Road
San Rafael, California 94903

Attn: Irene Huang, PE

Re: Results of Laboratory Testing
Sludge Pond Sampling and Testing for
Secondary Treatment Plant Upgrade and Recycled Water Expansion
San Rafael, California

Introduction

This letter presents the results of laboratory testing performed on soil samples that were collected from the two existing sludge ponds within the Las Gallinas Valley Sanitary District's treatment plant at 300 Smith Ranch Road in San Rafael, California. The two ponds encompass an approximately 0.7-acre area located near the southeast end of the treatment plant, as shown on Figure 1. We understand future upgrades to the treatment plant will include removing the existing sludge ponds to facilitate construction of a new anoxic and aeration basin in roughly the same location. Site grading for the new basin structure is expected to include excavation to lower grades within the existing pond areas. The purpose of our services is to perform environmental laboratory testing on samples collected from within the existing ponds to screen the soils for potential contamination.

Environmental Laboratory Testing

We visited the site on July 6, 2018 to observe excavation of a test pit at each pond location. The test pits were excavated to depths of about five to six feet using a small excavator and the soil conditions encountered at each pit location are summarized below. At the time of our visit, the sludge ponds contained about two to three feet of water and logging of the test pit side walls was not possible. Therefore, the interpreted soil conditions within the pit are based upon bulk samples that were obtained from the backhoe bucket.

Test Pit 1 (Northern Sludge Pond)

- 0 to 1 ft: Organics/Sludge – black, saturated, very soft, omits strong organic odor
- 1 to 2 ft: Charcoal filter material
- 2 to 5 ft: Bay Mud – light gray, wet to saturated, very soft to soft, high plasticity

Test Pit 2 (Southern Sludge Pond)

- 0 to 0.5 ft: Organics/Sludge – black, saturated, very soft, omits strong organic odor
- 0.5 to 6 ft: Bay Mud – light gray, wet, very soft to medium stiff, high plasticity

We collected bulk samples of the materials at various depths at each test pit location. The bulk samples were visually classified and samples from the upper three to four feet were thoroughly mixed to create one composite sample for each test pit location. The composite samples were sealed to prevent moisture loss, placed in a cooler on ice and were transported to Analytical Sciences of Petaluma, California for environmental laboratory testing. The composite samples were tested to provide preliminary information pertaining to potential contamination. The analyses of the composite sample included the following tests:

- Volatile Hydrocarbons by GC/MS (EPA 8260B)
- Total Petroleum Hydrocarbons, Gasoline (EPA 8015B)
- Total Petroleum Hydrocarbons, Diesel & Motor Oil (EPA 8015B)
- CAM 17 Metals (EPA 6010B)
- Semi-Volatile Organics (SW8270C)

The results of the environmental laboratory testing are presented in Appendix B.

Conclusions

Hazardous waste disposal is regulated at the Federal level by the Resource Conservation and Recovery Act and at the State level by Title 22 of the California Administrative Manual and the California Department of Toxic Substance Control. Additional regulations are locally imposed by the San Francisco Bay Area Regional Water Quality Control Board. The results of the environmental laboratory testing indicate the soils obtained from the test pits are generally not considered hazardous toxic waste in accordance with federal and state regulations. While a number of the CAM 17 metals were detected in the samples from both ponds, the test results indicate the levels are below the Title 22 specified total threshold limit concentration. Additionally, while relatively low levels of gasoline, motor oil, and a number of volatile hydrocarbons (gasoline constituents) were detected in the composite sample from the northern pond, the levels are below the San Francisco Bay Area Regional Water Quality Control Board's¹ "Tier 1" Environmental Screening Levels for soil.

While the pond materials do not appear to be considered hazardous per federal and state regulations, we note that individual landfills often impose their own criteria for soil disposal. Therefore, if offsite disposal of the sludge pond material is required, the test results should be provided to the potential disposal locations to confirm the material meets their specific acceptance criteria. From experience with similar projects, we anticipate that the materials would not be accepted at the Redwood Landfill in Novato based on the results of the total petroleum hydrocarbons testing. Other potential disposal locations may include the Keller Canyon Landfill in Pittsburg, the Forward Landfill in Stockton, the Casco Road Landfill in Livermore, or the Newby Island Landfill in Milpitas.

¹ San Francisco Bay Regional Water Quality Control Board, "Environmental Screening Levels, Rev 3" (www.waterboards.ca.gov), February 2016.

Las Gallinas Valley Sanitary District
Page 3

July 17, 2018

We trust that this letter contains the information you require at this time. Please do not hesitate to contact us should there be any questions or should you wish to discuss the results of our testing.

Very truly yours,
MILLER PACIFIC ENGINEERING GROUP



Rusty Arend
Geotechnical Engineer No. 3031
(Expires 6/30/19)

REVIEWED BY



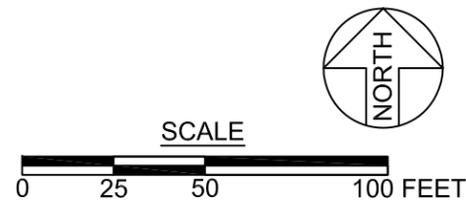
Scott Stephens
Geotechnical Engineer No. 2398
(Expires 6/30/19)

Attachments: Figure 1, Appendices A and B



LEGEND:

 APPROX. LOCATION OF TEST PIT



MPEG
MILLER PACIFIC
ENGINEERING GROUP

A CALIFORNIA CORPORATION, © 2018, ALL RIGHTS RESERVED
 FILE: 1009_093 Figures.dwg

504 Redwood Blvd.
 Suite 220
 Novato, CA 94947
 T 415 / 382-3444
 F 415 / 382-3450
 www.millerpac.com

SLUDGE POND & TEST PIT LOCATIONS		1 FIGURE
LGVSD Secondary Treatment Plant Upgrades San Rafael, California		
Project No. 1009.094	Date: 7/16/2018	

Drawn	RCA
Checked	SAS



APPENDIX A
ENVIRONMENTAL LABORATORY TEST RESULTS



Report Date: July 12, 2018

Laboratory Report

Rusty Arend
Miller Pacific Engineering - Novato
504 Redwood Blvd., Suite 220
Novato, CA 94947

Project Name: **LBUSD** **1009.094 - Sludge Ponds**
Lab Project Number: **8070904**

This 17 page report of analytical data has been reviewed and approved for release.

Michele Peters
Laboratory Director



Volatile Hydrocarbons by GC/MS

Lab#	Sample ID	Compound Name	Result (µg/kg)	RDL (µg/kg)
8070904-01	Pond 1	Dichlorodifluoromethane (F-12)	ND	2.0
		Chloromethane	ND	2.0
		Vinyl chloride	ND	2.0
		Chloroethane (CE)	ND	2.0
		Bromomethane	ND	2.0
		Trichlorofluoromethane (F-11)	ND	2.0
		Trichlorotrifluoroethane (F-113)	ND	2.0
		1,1-Dichloroethene (1,1-DCE)	ND	2.0
		Methylene chloride	ND	2.0
		trans-1,2-Dichloroethene	ND	2.0
		1,1-Dichloroethane (1,1-DCA)	ND	2.0
		cis-1,2-Dichloroethene (c1,2-DCE)	ND	2.0
		2,2-Dichloropropane	ND	2.0
		Chloroform (THM1)	ND	2.0
		Bromochloromethane	ND	2.0
		1,1,1-Trichloroethane (TCA)	ND	2.0
		1,2-Dichloroethane (EDC)	ND	2.0
		1,1-Dichloropropene	ND	2.0
		Carbon tetrachloride	ND	2.0
		Benzene	ND	2.0
		Trichloroethene (TCE)	ND	2.0
		1,2-Dichloropropane (DCP)	ND	2.0
		Dibromomethane	ND	2.0
		Bromodichloromethane (THM2)	ND	2.0
		cis-1,3-Dichloropropene	ND	2.0
		Toluene	ND	2.0
		1,1,2-Trichloroethane	ND	2.0
		1,3-Dichloropropane	ND	2.0
		Dibromochloromethane (THM3)	ND	2.0
		Tetrachloroethene (PCE)	ND	2.0
		1,2-Dibromoethane (EDB)	ND	2.0
		Chlorobenzene	13	2.0
		1,1,1,2-Tetrachloroethane	ND	2.0
		Ethylbenzene	ND	2.0
		m,p-Xylene	ND	2.0
		Styrene	ND	2.0
		o-Xylene	ND	2.0
		Bromoform (THM4)	ND	2.0
		1,1,2,2-Tetrachloroethane	ND	2.0
		Isopropylbenzene	ND	2.0
		1,2,3-Trichloropropane	ND	2.0
		Bromobenzene	ND	2.0
		n-Propyl Benzene	ND	2.0
		2-Chlorotoluene	ND	2.0
		4-Chlorotoluene	ND	2.0
		1,3,5-Trimethylbenzene	ND	2.0
		tert-Butylbenzene	ND	2.0
		1,2,4-Trimethylbenzene	4.4	2.0
		sec-Butylbenzene	ND	2.0



Volatile Hydrocarbons by GC/MS

Lab#	Sample ID	Compound Name	Result (µg/kg)	RDL (µg/kg)
8070904-01	Pond 1	1,3-Dichlorobenzene	21	2.0
		1,4-Dichlorobenzene	16	2.0
		1,2-Dichlorobenzene	ND	2.0
		p-Isopropyltoluene	ND	2.0
		n-Butylbenzene	3.8	2.0
		1,2-Dibromo-3-chloropropane	ND	2.0
		1,2,4-Trichlorobenzene	ND	2.0
		Naphthalene	6.2	2.0
		Hexachlorobutadiene	ND	2.0
		1,2,3-Trichlorobenzene	ND	2.0
		Tertiary Butyl Alcohol (TBA)	ND	25
		Methyl tert-Butyl Ether (MTBE)	ND	2.0
		Di-isopropyl Ether (DIPE)	ND	2.0
		Ethyl tert-Butyl Ether (ETBE)	ND	2.0
		Tert-Amyl Methyl Ether (TAME)	ND	2.0
Surrogates	Result (µg/kg)	% Recovery	Acceptance Range (%)	
Dibromofluoromethane	47.3	98	70-130	
Toluene-d8	50.7	104	70-130	
4-Bromofluorobenzene	48.2	99	70-130	

Date Sampled:	07/06/18	Date Analyzed:	07/09/18	QC Batch: B017838
Date Received:	07/09/18	Method:	EPA 8260B	



Volatile Hydrocarbons by GC/MS

Lab#	Sample ID	Compound Name	Result (µg/kg)	RDL (µg/kg)
8070904-02	Pond 2	Dichlorodifluoromethane (F-12)	ND	2.0
		Chloromethane	ND	2.0
		Vinyl chloride	ND	2.0
		Chloroethane (CE)	ND	2.0
		Bromomethane	ND	2.0
		Trichlorofluoromethane (F-11)	ND	2.0
		Trichlorotrifluoroethane (F-113)	ND	2.0
		1,1-Dichloroethene (1,1-DCE)	ND	2.0
		Methylene chloride	ND	2.0
		trans-1,2-Dichloroethene	ND	2.0
		1,1-Dichloroethane (1,1-DCA)	ND	2.0
		cis-1,2-Dichloroethene (c1,2-DCE)	ND	2.0
		2,2-Dichloropropane	ND	2.0
		Chloroform (THM1)	ND	2.0
		Bromochloromethane	ND	2.0
		1,1,1-Trichloroethane (TCA)	ND	2.0
		1,2-Dichloroethane (EDC)	ND	2.0
		1,1-Dichloropropene	ND	2.0
		Carbon tetrachloride	ND	2.0
		Benzene	ND	2.0
		Trichloroethene (TCE)	ND	2.0
		1,2-Dichloropropane (DCP)	ND	2.0
		Dibromomethane	ND	2.0
		Bromodichloromethane (THM2)	ND	2.0
		cis-1,3-Dichloropropene	ND	2.0
		Toluene	ND	2.0
		1,1,2-Trichloroethane	ND	2.0
		1,3-Dichloropropane	ND	2.0
		Dibromochloromethane (THM3)	ND	2.0
		Tetrachloroethene (PCE)	ND	2.0
		1,2-Dibromoethane (EDB)	ND	2.0
		Chlorobenzene	ND	2.0
		1,1,1,2-Tetrachloroethane	ND	2.0
		Ethylbenzene	ND	2.0
		m,p-Xylene	ND	2.0
		Styrene	ND	2.0
		o-Xylene	ND	2.0
		Bromoform (THM4)	ND	2.0
		1,1,2,2-Tetrachloroethane	ND	2.0
		Isopropylbenzene	ND	2.0
		1,2,3-Trichloropropane	ND	2.0
		Bromobenzene	ND	2.0
		n-Propyl Benzene	ND	2.0
		2-Chlorotoluene	ND	2.0
		4-Chlorotoluene	ND	2.0
		1,3,5-Trimethylbenzene	ND	2.0
		tert-Butylbenzene	ND	2.0
		1,2,4-Trimethylbenzene	ND	2.0
		sec-Butylbenzene	ND	2.0



Volatile Hydrocarbons by GC/MS

Lab#	Sample ID	Compound Name	Result (µg/kg)	RDL (µg/kg)
8070904-02	Pond 2	1,3-Dichlorobenzene	ND	2.0
		1,4-Dichlorobenzene	ND	2.0
		1,2-Dichlorobenzene	ND	2.0
		p-Isopropyltoluene	ND	2.0
		n-Butylbenzene	ND	2.0
		1,2-Dibromo-3-chloropropane	ND	2.0
		1,2,4-Trichlorobenzene	ND	2.0
		Naphthalene	ND	2.0
		Hexachlorobutadiene	ND	2.0
		1,2,3-Trichlorobenzene	ND	2.0
		Tertiary Butyl Alcohol (TBA)	ND	25
		Methyl tert-Butyl Ether (MTBE)	ND	2.0
		Di-isopropyl Ether (DIPE)	ND	2.0
		Ethyl tert-Butyl Ether (ETBE)	ND	2.0
		Tert-Amyl Methyl Ether (TAME)	ND	2.0
Surrogates	Result (µg/kg)	% Recovery	Acceptance Range (%)	
Dibromofluoromethane	45.7	94	70-130	
Toluene-d8	49.7	102	70-130	
4-Bromofluorobenzene	51.1	105	70-130	

Date Sampled: 07/06/18	Date Analyzed: 07/09/18	QC Batch: B017838
Date Received: 07/09/18	Method: EPA 8260B	

TPH Gasoline

Lab#	Sample ID	Compound Name	Result (mg/kg)	RDL (mg/kg)
8070904-01	Pond 1	Gasoline	2.4	1.0

Date Sampled: 07/06/18	Date Analyzed: 07/09/18	QC Batch: B017836
Date Received: 07/09/18	Method: EPA 8015B	



TPH Gasoline

Lab#	Sample ID	Compound Name	Result (mg/kg)	RDL (mg/kg)
8070904-02	Pond 2	Gasoline	ND	1.0

Date Sampled:	07/06/18	Date Analyzed:	07/09/18	QC Batch: B017836
Date Received:	07/09/18	Method:	EPA 8015B	

TPH Diesel & Motor Oil

Lab#	Sample ID	Compound Name	Result (mg/kg)	RDL (mg/kg)
8070904-01	Pond 1	Diesel	ND	5.0
		Motor Oil	250	50

Date Sampled:	07/06/18	Date Analyzed:	07/10/18	QC Batch: B017842
Date Received:	07/09/18	Method:	EPA 8015B	

TPH Diesel & Motor Oil

Lab#	Sample ID	Compound Name	Result (mg/kg)	RDL (mg/kg)
8070904-02	Pond 2	Diesel	ND	5.0
		Motor Oil	ND	50

Date Sampled:	07/06/18	Date Analyzed:	07/10/18	QC Batch: B017842
Date Received:	07/09/18	Method:	EPA 8015B	



CAM Metals

Lab#	Sample ID	Compound Name	Result (mg/kg)	RDL (mg/kg)
8070904-01	Pond 1	Antimony (Sb)	ND	5.0
		Arsenic (As)	1.5	1.5
		Barium (Ba)	100	2.0
		Beryllium (Be)	ND	0.50
		Cadmium (Cd)	ND	0.50
		Chromium (Cr)	29	1.5
		Cobalt (Co)	3.4	1.5
		Copper (Cu)	45	2.0
		Lead (Pb)	9.1	3.0
		Molybdenum (Mo)	ND	1.0
		Nickel (Ni)	28	2.0
		Selenium (Se)	ND	5.0
		Silver (Ag)	12	1.0
		Thallium (Tl)	ND	5.0
		Vanadium (V)	14	2.0
		Zinc (Zn)	180	5.0

Date Sampled:	07/06/18	Date Analyzed:	07/11/18	QC Batch:	B017830
Date Received:	07/09/18	Method:	EPA 6010B		



CAM Metals

Lab#	Sample ID	Compound Name	Result (mg/kg)	RDL (mg/kg)
8070904-02	Pond 2	Antimony (Sb)	ND	5.0
		Arsenic (As)	2.4	1.5
		Barium (Ba)	59	2.0
		Beryllium (Be)	ND	0.50
		Cadmium (Cd)	ND	0.50
		Chromium (Cr)	33	1.5
		Cobalt (Co)	8.4	1.5
		Copper (Cu)	35	2.0
		Lead (Pb)	15	3.0
		Molybdenum (Mo)	2.3	1.0
		Nickel (Ni)	42	2.0
		Selenium (Se)	ND	5.0
		Silver (Ag)	7.7	1.0
		Thallium (Tl)	ND	5.0
		Vanadium (V)	21	2.0
		Zinc (Zn)	80	5.0

Date Sampled:	07/06/18	Date Analyzed:	07/11/18	QC Batch:	B017830
Date Received:	07/09/18	Method:	EPA 6010B		

Mercury

Lab#	Sample ID	Compound Name	Result (mg/kg)	RDL (mg/kg)
8070904-01	Pond 1	Mercury (Hg)	1.1	0.20

Date Sampled:	07/06/18	Date Analyzed:	07/11/18	QC Batch:	B017785
Date Received:	07/09/18	Method:	EPA 7471A		

Mercury

Lab#	Sample ID	Compound Name	Result (mg/kg)	RDL (mg/kg)
8070904-02	Pond 2	Mercury (Hg)	0.30	0.10

Date Sampled:	07/06/18	Date Analyzed:	07/11/18	QC Batch:	B017785
Date Received:	07/09/18	Method:	EPA 7471A		



Notes and Definitions

RDL	Reporting Detection Limit
ND	Analyte NOT DETECTED at or above the reporting detection limit (RDL)
RPD	Relative Percent Difference
NR	Not Reported



Glossary of Terms & Qualifier Definitions

Client: Analytical Sciences
Project: 8070904; LBUSD-Sludge Ponds
WorkOrder: 1807339

Glossary Abbreviation

%D	Serial Dilution Percent Difference
95% Interval	95% Confident Interval
DF	Dilution Factor
DI WET	(DISTLC) Waste Extraction Test using DI water
DISS	Dissolved (direct analysis of 0.45 µm filtered and acidified water sample)
DLT	Dilution Test (Serial Dilution)
DUP	Duplicate
EDL	Estimated Detection Limit
ERS	External reference sample. Second source calibration verification.
ITEF	International Toxicity Equivalence Factor
LCS	Laboratory Control Sample
MB	Method Blank
MB % Rec	% Recovery of Surrogate in Method Blank, if applicable
MDL	Method Detection Limit
ML	Minimum Level of Quantitation
MS	Matrix Spike
MSD	Matrix Spike Duplicate
N/A	Not Applicable
ND	Not detected at or above the indicated MDL or RL
NR	Data Not Reported due to matrix interference or insufficient sample amount.
PDS	Post Digestion Spike
PDSD	Post Digestion Spike Duplicate
PF	Prep Factor
RD	Relative Difference
RL	Reporting Limit (The RL is the lowest calibration standard in a multipoint calibration.)
RPD	Relative Percent Deviation
RRT	Relative Retention Time
SPK Val	Spike Value
SPKRef Val	Spike Reference Value
SPLP	Synthetic Precipitation Leachate Procedure
ST	Sorbent Tube
TCLP	Toxicity Characteristic Leachate Procedure
TEQ	Toxicity Equivalents
WET (STLC)	Waste Extraction Test (Soluble Threshold Limit Concentration)

Analytical Qualifiers

a4 Reporting limits raised due to the sample's matrix prohibiting a full volume extraction.



Glossary of Terms & Qualifier Definitions

Client: Analytical Sciences
Project: 8070904; LBUSD-Sludge Ponds
WorkOrder: 1807339

Quality Control Qualifiers

F2 LCS/LCSD recovery and/or RPD is out of acceptance criteria.



Analytical Report

Client: Analytical Sciences
Date Received: 7/10/18 11:00
Date Prepared: 7/10/18
Project: 8070904; LBUSD-Sludge Ponds

WorkOrder: 1807339
Extraction Method: SW3550B
Analytical Method: SW8270C
Unit: mg/Kg

Semi-Volatile Organics

Client ID	Lab ID	Matrix	Date Collected	Instrument	Batch ID
Pond 1	1807339-001A	Soil	07/06/2018 08:30	GC21 07101839.D	161168
Analytes	Result	RL	DF	Date Analyzed	
Acenaphthene	ND	2.0	1	07/11/2018 02:49	
Acenaphthylene	ND	2.0	1	07/11/2018 02:49	
Acetochlor	ND	2.0	1	07/11/2018 02:49	
Anthracene	ND	2.0	1	07/11/2018 02:49	
Benzidine	ND	10	1	07/11/2018 02:49	
Benzo (a) anthracene	ND	2.0	1	07/11/2018 02:49	
Benzo (a) pyrene	ND	2.0	1	07/11/2018 02:49	
Benzo (b) fluoranthene	ND	2.0	1	07/11/2018 02:49	
Benzo (g,h,i) perylene	ND	2.0	1	07/11/2018 02:49	
Benzo (k) fluoranthene	ND	2.0	1	07/11/2018 02:49	
Benzyl Alcohol	ND	10	1	07/11/2018 02:49	
1,1-Biphenyl	ND	2.0	1	07/11/2018 02:49	
Bis (2-chloroethoxy) Methane	ND	2.0	1	07/11/2018 02:49	
Bis (2-chloroethyl) Ether	ND	2.0	1	07/11/2018 02:49	
Bis (2-chloroisopropyl) Ether	ND	2.0	1	07/11/2018 02:49	
Bis (2-ethylhexyl) Adipate	ND	2.0	1	07/11/2018 02:49	
Bis (2-ethylhexyl) Phthalate	ND	2.0	1	07/11/2018 02:49	
4-Bromophenyl Phenyl Ether	ND	2.0	1	07/11/2018 02:49	
Butylbenzyl Phthalate	ND	2.0	1	07/11/2018 02:49	
4-Chloroaniline	ND	4.0	1	07/11/2018 02:49	
4-Chloro-3-methylphenol	ND	2.0	1	07/11/2018 02:49	
2-Chloronaphthalene	ND	2.0	1	07/11/2018 02:49	
2-Chlorophenol	ND	2.0	1	07/11/2018 02:49	
4-Chlorophenyl Phenyl Ether	ND	2.0	1	07/11/2018 02:49	
Chrysene	ND	2.0	1	07/11/2018 02:49	
Dibenzo (a,h) anthracene	ND	2.0	1	07/11/2018 02:49	
Dibenzofuran	ND	2.0	1	07/11/2018 02:49	
Di-n-butyl Phthalate	ND	2.0	1	07/11/2018 02:49	
1,2-Dichlorobenzene	ND	2.0	1	07/11/2018 02:49	
1,3-Dichlorobenzene	ND	2.0	1	07/11/2018 02:49	
1,4-Dichlorobenzene	ND	2.0	1	07/11/2018 02:49	
3,3-Dichlorobenzidine	ND	4.0	1	07/11/2018 02:49	
2,4-Dichlorophenol	ND	2.0	1	07/11/2018 02:49	
Diethyl Phthalate	ND	2.0	1	07/11/2018 02:49	
2,4-Dimethylphenol	ND	2.0	1	07/11/2018 02:49	
Dimethyl Phthalate	ND	2.0	1	07/11/2018 02:49	
4,6-Dinitro-2-methylphenol	ND	10	1	07/11/2018 02:49	

(Cont.)



Analytical Report

Client: Analytical Sciences
Date Received: 7/10/18 11:00
Date Prepared: 7/10/18
Project: 8070904; LBUSD-Sludge Ponds

WorkOrder: 1807339
Extraction Method: SW3550B
Analytical Method: SW8270C
Unit: mg/Kg

Semi-Volatile Organics

Client ID	Lab ID	Matrix	Date Collected	Instrument	Batch ID
Pond 1	1807339-001A	Soil	07/06/2018 08:30	GC21 07101839.D	161168
Analytes	Result	RL	DF	Date Analyzed	
2,4-Dinitrophenol	ND	50	1	07/11/2018 02:49	
2,4-Dinitrotoluene	ND	2.0	1	07/11/2018 02:49	
2,6-Dinitrotoluene	ND	2.0	1	07/11/2018 02:49	
Di-n-octyl Phthalate	ND	4.0	1	07/11/2018 02:49	
1,2-Diphenylhydrazine	ND	2.0	1	07/11/2018 02:49	
Fluoranthene	ND	2.0	1	07/11/2018 02:49	
Fluorene	ND	2.0	1	07/11/2018 02:49	
Hexachlorobenzene	ND	2.0	1	07/11/2018 02:49	
Hexachlorobutadiene	ND	2.0	1	07/11/2018 02:49	
Hexachlorocyclopentadiene	ND	10	1	07/11/2018 02:49	
Hexachloroethane	ND	2.0	1	07/11/2018 02:49	
Indeno (1,2,3-cd) pyrene	ND	2.0	1	07/11/2018 02:49	
Isophorone	ND	2.0	1	07/11/2018 02:49	
2-Methylnaphthalene	ND	2.0	1	07/11/2018 02:49	
2-Methylphenol (o-Cresol)	ND	2.0	1	07/11/2018 02:49	
3 & 4-Methylphenol (m,p-Cresol)	ND	2.0	1	07/11/2018 02:49	
Naphthalene	ND	2.0	1	07/11/2018 02:49	
2-Nitroaniline	ND	10	1	07/11/2018 02:49	
3-Nitroaniline	ND	10	1	07/11/2018 02:49	
4-Nitroaniline	ND	10	1	07/11/2018 02:49	
Nitrobenzene	ND	2.0	1	07/11/2018 02:49	
2-Nitrophenol	ND	10	1	07/11/2018 02:49	
4-Nitrophenol	ND	10	1	07/11/2018 02:49	
N-Nitrosodiphenylamine	ND	2.0	1	07/11/2018 02:49	
N-Nitrosodi-n-propylamine	ND	2.0	1	07/11/2018 02:49	
Pentachlorophenol	ND	10	1	07/11/2018 02:49	
Phenanthrene	ND	2.0	1	07/11/2018 02:49	
Phenol	ND	2.0	1	07/11/2018 02:49	
Pyrene	ND	2.0	1	07/11/2018 02:49	
Pyridine	ND	2.0	1	07/11/2018 02:49	
1,2,4-Trichlorobenzene	ND	2.0	1	07/11/2018 02:49	
2,4,5-Trichlorophenol	ND	2.0	1	07/11/2018 02:49	
2,4,6-Trichlorophenol	ND	2.0	1	07/11/2018 02:49	

(Cont.)



Analytical Report

Client: Analytical Sciences
Date Received: 7/10/18 11:00
Date Prepared: 7/10/18
Project: 8070904; LBUSD-Sludge Ponds

WorkOrder: 1807339
Extraction Method: SW3550B
Analytical Method: SW8270C
Unit: mg/Kg

Semi-Volatile Organics

Client ID	Lab ID	Matrix	Date Collected	Instrument	Batch ID
Pond 1	1807339-001A	Soil	07/06/2018 08:30	GC21 07101839.D	161168

Analytes	Result	RL	DF	Date Analyzed
<u>Surrogates</u>	<u>REC (%)</u>	<u>Limits</u>		
2-Fluorophenol	120	30-130		07/11/2018 02:49
Phenol-d5	94	30-130		07/11/2018 02:49
Nitrobenzene-d5	101	30-130		07/11/2018 02:49
2-Fluorobiphenyl	85	30-130		07/11/2018 02:49
2,4,6-Tribromophenol	106	16-130		07/11/2018 02:49
4-Terphenyl-d14	84	30-130		07/11/2018 02:49

Analyst(s): REB

Analytical Comments: a4

(Cont.)

CA ELAP 1644 • NELAP 4033ORELAP



Analytical Report

Client: Analytical Sciences
Date Received: 7/10/18 11:00
Date Prepared: 7/10/18
Project: 8070904; LBUSD-Sludge Ponds

WorkOrder: 1807339
Extraction Method: SW3550B
Analytical Method: SW8270C
Unit: mg/Kg

Semi-Volatile Organics

Client ID	Lab ID	Matrix	Date Collected	Instrument	Batch ID
Pond 2	1807339-002A	Soil	07/06/2018 08:30	GC21 07101840.D	161168
Analytes	Result	RL	DF	Date Analyzed	
Acenaphthene	ND	2.0	1	07/11/2018 03:16	
Acenaphthylene	ND	2.0	1	07/11/2018 03:16	
Acetochlor	ND	2.0	1	07/11/2018 03:16	
Anthracene	ND	2.0	1	07/11/2018 03:16	
Benzidine	ND	10	1	07/11/2018 03:16	
Benzo (a) anthracene	ND	2.0	1	07/11/2018 03:16	
Benzo (a) pyrene	ND	2.0	1	07/11/2018 03:16	
Benzo (b) fluoranthene	ND	2.0	1	07/11/2018 03:16	
Benzo (g,h,i) perylene	ND	2.0	1	07/11/2018 03:16	
Benzo (k) fluoranthene	ND	2.0	1	07/11/2018 03:16	
Benzyl Alcohol	ND	10	1	07/11/2018 03:16	
1,1-Biphenyl	ND	2.0	1	07/11/2018 03:16	
Bis (2-chloroethoxy) Methane	ND	2.0	1	07/11/2018 03:16	
Bis (2-chloroethyl) Ether	ND	2.0	1	07/11/2018 03:16	
Bis (2-chloroisopropyl) Ether	ND	2.0	1	07/11/2018 03:16	
Bis (2-ethylhexyl) Adipate	ND	2.0	1	07/11/2018 03:16	
Bis (2-ethylhexyl) Phthalate	ND	2.0	1	07/11/2018 03:16	
4-Bromophenyl Phenyl Ether	ND	2.0	1	07/11/2018 03:16	
Butylbenzyl Phthalate	ND	2.0	1	07/11/2018 03:16	
4-Chloroaniline	ND	4.0	1	07/11/2018 03:16	
4-Chloro-3-methylphenol	ND	2.0	1	07/11/2018 03:16	
2-Chloronaphthalene	ND	2.0	1	07/11/2018 03:16	
2-Chlorophenol	ND	2.0	1	07/11/2018 03:16	
4-Chlorophenyl Phenyl Ether	ND	2.0	1	07/11/2018 03:16	
Chrysene	ND	2.0	1	07/11/2018 03:16	
Dibenzo (a,h) anthracene	ND	2.0	1	07/11/2018 03:16	
Dibenzofuran	ND	2.0	1	07/11/2018 03:16	
Di-n-butyl Phthalate	ND	2.0	1	07/11/2018 03:16	
1,2-Dichlorobenzene	ND	2.0	1	07/11/2018 03:16	
1,3-Dichlorobenzene	ND	2.0	1	07/11/2018 03:16	
1,4-Dichlorobenzene	ND	2.0	1	07/11/2018 03:16	
3,3-Dichlorobenzidine	ND	4.0	1	07/11/2018 03:16	
2,4-Dichlorophenol	ND	2.0	1	07/11/2018 03:16	
Diethyl Phthalate	ND	2.0	1	07/11/2018 03:16	
2,4-Dimethylphenol	ND	2.0	1	07/11/2018 03:16	
Dimethyl Phthalate	ND	2.0	1	07/11/2018 03:16	
4,6-Dinitro-2-methylphenol	ND	10	1	07/11/2018 03:16	

(Cont.)



Analytical Report

Client: Analytical Sciences
Date Received: 7/10/18 11:00
Date Prepared: 7/10/18
Project: 8070904; LBUSD-Sludge Ponds

WorkOrder: 1807339
Extraction Method: SW3550B
Analytical Method: SW8270C
Unit: mg/Kg

Semi-Volatile Organics

Client ID	Lab ID	Matrix	Date Collected	Instrument	Batch ID
Pond 2	1807339-002A	Soil	07/06/2018 08:30	GC21 07101840.D	161168
Analytes	Result	RL	DF	Date Analyzed	
2,4-Dinitrophenol	ND	50	1	07/11/2018 03:16	
2,4-Dinitrotoluene	ND	2.0	1	07/11/2018 03:16	
2,6-Dinitrotoluene	ND	2.0	1	07/11/2018 03:16	
Di-n-octyl Phthalate	ND	4.0	1	07/11/2018 03:16	
1,2-Diphenylhydrazine	ND	2.0	1	07/11/2018 03:16	
Fluoranthene	ND	2.0	1	07/11/2018 03:16	
Fluorene	ND	2.0	1	07/11/2018 03:16	
Hexachlorobenzene	ND	2.0	1	07/11/2018 03:16	
Hexachlorobutadiene	ND	2.0	1	07/11/2018 03:16	
Hexachlorocyclopentadiene	ND	10	1	07/11/2018 03:16	
Hexachloroethane	ND	2.0	1	07/11/2018 03:16	
Indeno (1,2,3-cd) pyrene	ND	2.0	1	07/11/2018 03:16	
Isophorone	ND	2.0	1	07/11/2018 03:16	
2-Methylnaphthalene	ND	2.0	1	07/11/2018 03:16	
2-Methylphenol (o-Cresol)	ND	2.0	1	07/11/2018 03:16	
3 & 4-Methylphenol (m,p-Cresol)	ND	2.0	1	07/11/2018 03:16	
Naphthalene	ND	2.0	1	07/11/2018 03:16	
2-Nitroaniline	ND	10	1	07/11/2018 03:16	
3-Nitroaniline	ND	10	1	07/11/2018 03:16	
4-Nitroaniline	ND	10	1	07/11/2018 03:16	
Nitrobenzene	ND	2.0	1	07/11/2018 03:16	
2-Nitrophenol	ND	10	1	07/11/2018 03:16	
4-Nitrophenol	ND	10	1	07/11/2018 03:16	
N-Nitrosodiphenylamine	ND	2.0	1	07/11/2018 03:16	
N-Nitrosodi-n-propylamine	ND	2.0	1	07/11/2018 03:16	
Pentachlorophenol	ND	10	1	07/11/2018 03:16	
Phenanthrene	ND	2.0	1	07/11/2018 03:16	
Phenol	ND	2.0	1	07/11/2018 03:16	
Pyrene	ND	2.0	1	07/11/2018 03:16	
Pyridine	ND	2.0	1	07/11/2018 03:16	
1,2,4-Trichlorobenzene	ND	2.0	1	07/11/2018 03:16	
2,4,5-Trichlorophenol	ND	2.0	1	07/11/2018 03:16	
2,4,6-Trichlorophenol	ND	2.0	1	07/11/2018 03:16	

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CA ELAP 1644 • NELAP 4033ORELAP

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. Design of the asphalt shall meet all requirements as shown in Section 319000, "Geotechnical Report," with a Traffic Index of 5.5.

2.2 AGGREGATES

- A. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- B. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
- C. 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. 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. Recompress existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseal 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. Recompress 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. 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.
- D. 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. Relative Density: 95 percent of reference maximum theoretical density according to ASTM D 1557-00.
- 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.
 - 4. Pervious Concrete.

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.

2.9 PERVIOUS CONCRETE

- A. Experience: The placing Contractor shall furnish owner/engineer/ a statement attesting to qualifications, experience, sample of workmanship and installed product (e.g. references and project addresses).
- B. If either the Pervious Placing Contractor or the Pervious Concrete Producer have no prior experience with Pervious Concrete Pavement, the Contractor shall retain an experienced Consultant to supervise base preparation, production, placement, finishing and curing. Expense of the consultant shall be the responsibility of the Contractor.
- C. Concrete Mix Design: Contractor shall furnish a proposed mix design with proportions of materials to Owner or Gent prior to commencement of work. Cement content shall be a minimum of 580 pounds per cubic yard, with total cementations content to be a minimum of 630 pound per cubic yard. Water cement ratio shall be a maximum of 0.30. The data shall include unit weights determined in accordance with ASTM C29 paragraph 11, jigging procedure. Based on the unit weight of the mix, compacted void content of the mix shall be a minimum of 10% and a maximum of 20%.
- D. Cement: Portland cement Type II conforming to ASTM C150 or Portland cement Type IP or IS conforming to ASTM C595.
- E. Aggregate: Use 3/8 coarse aggregate that meets 3/8 to No. 16 per ASTM C33, or meeting 3/8 to No. 50 per ASTM D448. Smooth rock aggregate is recommended and has been found to perform better than crushed rock aggregates. If other gradation of aggregate is to be use, submit data on proposed material to owner for approval. Larger aggregate sizes increase pore size but decrease workability. Aggregates that are well graded reduce porosity, and may require reduction of minimums require written approval from the Owner's Representative.
- F. Chemical Admixtures:
- Air entraining agents shall comply with ASTM C260.
 - Type A Water Reducing Admixtures shall comply with ASTM C494.
 - Type B Retarding Admixtures shall comply with ASTM C494.
 - Type D Water Reducing/Retarding Admixtures shall comply with ASTM C494.
 - Hydration stabilizer shall meet the requirement of ASTM C494 Type B Retarding Admixtures or Type D Water Reducing/Retarding Admixtures.
Note: A hydration stabilizer can be utilized and is recommended in the design and production of pervious concrete. Hydration stabilizer suspends cement hydration by forming a protective barrier around the cementitious particles, which delay the particles from achieving initial set.
- G. Mineral Admixture:
- Fly ash conforming to ASTM C618 may be used in amounts not to exceed 20% of total cementitious materials.
 - Ground Iron Blast-Furnace Slag conforming to ASTM C989 may be used in amounts not to exceed 50% by weight of total cementitious material.
- H. Bituminous mixtures shall be delivered to the roadbed at temperatures specified in Section 39 of the current State Standard Specifications. Spreading of the mixture shall be in accordance with

Section 39 of the State Standard Specifications. All loads shall be covered with tarpaulin or other material during transportation.

- I. Pervious concrete shall match the existing adjoining pavement in thickness as a minimum, or as indicated in the design drawing standards, whichever is greater.

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, unlevelled 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 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 221066
- 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 221066 entitled, "Pipeline Testing".

END OF SECTION 331400

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.
 9. Information on the protective lining system (see Paragraph E of this section) including system specifications, requirements, performance data, etc.
- E. All manholes shall be furnished with “T-Lock” poly-vinyl chloride lining coatings on interior surfaces (or approved equal system).
- F. 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.
- G. 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.
- H. 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.
- I. 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.
- J. Manhole riser sections shall be greater than 12 inches in height.
- K. 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. 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.

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.

- D. 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.

- E. 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.

- F. 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.

- G. 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.

- H. Lifting holes shall be plugged with a precast concrete plug sealed with a non-shrink grout.

- I. 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 than 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 338000

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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. UPS: Uninterruptible power supply.
19. VCP: Vendor control panel.
20. WAN: Wide area network

1.4 I&C SYSTEM REQUIREMENTS

- A. Work provided outside of Contractor's scope:
1. The following equipment is being furnished by the Owner:
 - a. No Owner furnished equipment.
 2. The following equipment is being furnished by others under separate contract(s):
 - a. See Volume 3, Appendix A, Owner Selected Equipment.
 3. All PLC equipment being supplied by the IS is to be programmed by the Owner's Programmer.
 - a. All PLC equipment not specified in Volume 3, Appendix A, Owner Selected Equipment is being supplied by the IS, to be programmed by the Owner's Programmer.

4. All HMI equipment being supplied by the IS is to be programmed by the Owner's Programmer.
 5. All PLC and OIT Owner-selected equipment specified in Volume 3, Appendix A, shall be programmed by the equipment manufacturer. Those manufacturers shall provide complete control strategies, tag/register lists, and participate in all aspects of network system integration.
- B. 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 insure 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 Contractor Representatives, the Engineer, Package System PLC Vendors, Owner, and Owner's Programmer. 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 review submittal and coordination 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. Loop drawings design and submittal.
 - d. Recommended spare parts submittal.
 - e. PLC tag list submittal for Owner selected equipment (programmed by the equipment manufacturer)
 - f. HMI tag list submittal for Owner selected equipment (programmed by the equipment manufacturer)
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 the OSI. Oversee and coordinate the programming and integration with the OSI for a complete I&C System.
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 the 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 and sources.

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. Loop Drawings Submittal

1. Provide a comprehensive submittal that includes loop drawings for every control loop on the project. This includes but is not limited to all loops shown on the P&ID's, all loops associated with auxiliary inputs/outputs not shown on the P&ID's (e.g. UPS status information).
2. Loop drawings may only be finalized after all control panels, MCC's and other electrical submittals, and instrumentation submittals have been approved. Obtain all of the required information from each of these submittals to properly show the wiring of each control loop. The loop drawings shall not be submitted with incomplete information due to the lack of obtaining the appropriate information for each loop.
3. The loop drawings shall designed for and printed to 11x17 size paper. Divide the submittal into the following:
 - a. Laminated Cover and Back and Spiral Binding.
 - b. Table of Contents/Index (by loop number).
 - c. Loop Drawings.
4. Loop Drawings Requirements:
 - a. All loop drawings shall include a title block with the name of the firm designing the loop drawings. The title block shall also include project information, Owner information and/or logo, drawing number and description, revision fields and date.
 - b. All loop drawings shall be developed utilizing AutoCAD version 2008 or later. All loop drawings should be submitted in PDF and AutoCAD formats and as required by Section 013300.
 - c. Each loop drawing shall have a look and feel that follows that of the example loop drawing shown in the Contract Drawings.
 - d. Each loop drawing should have the following as a minimum:
 - 1) Six area divisions, from left to right which are:
 - a) Field/Process Area (this area will show field and process equipment).
 - b) Junction Boxes (this area will show any field junction boxes associated with the loop).
 - c) Local Control Panel (this area will show any local control panels associated with the loop).
 - d) Electrical Room (this area will show electrical equipment such as starters, VFD's, power feeders, etc. associated with the loop).
 - e) Programmable Logic Controller (this area will show PLC Inputs/Outputs associated with the loop).
 - f) SCADA (this area will show logical connections for the Inputs/Outputs from the PLC to the SCADA System).

- e. Each loop drawing will show each instrument or field device associated with the loop and its wiring connections and wire labels.
- f. Each electrical enclosure (junction box, local control panel, PLC panel, starter panel, etc.) will show terminal numbers and terminal block group references.
- g. All wires to be installed by the Contractor shall be dashed while all wires installed by the panel shop should be solid.
- h. Show continuation lines to associated loops that may interface with each loop.
- i. Show all wiring associated for the loop including power, controls, signal and communications.

E. 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 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.
- E. Experience requirements for the Control Systems Supervisor are specified later in this Section.

1.9 CONTROL SYSTEMS SUPERVISOR

- A. The Contractor shall designate an individual as project Control Systems Supervisor. This individual shall have at least 5 years of total experience in selection of instrumentation components and preparation of shop drawings, and startup and commissioning of instrumentation and control systems for municipal water or wastewater treatment plants. This

experience shall consist of at least \$15 million in electrical and instrumentation construction volume since January 1, 2010.

- B. The Control Systems Supervisor shall oversee all activities associated with planning, scheduling, documenting, and executing startup and testing of plant instrumentation and control systems. Systems include everything specified in Division 40, and applicable instrumentation and controls described in mechanical and package system specifications.
- C. Within 3 weeks of Notice to Proceed, the General Contractor shall provide a formal submittal declaring the identity of the Control Systems Supervisor, including evidence of his or her qualifications. This individual, once qualifications are favorably reviewed, may not be replaced without written consent of the Owner.
- D. The Control Systems Supervisor's responsibilities shall include, but not be limited to, the following:
 - 1. Participate in development of overall project schedules and construction sequencing, with specific attention to instrumentation and controls prerequisites and milestones.
 - 2. Take the lead in coordinating signal definitions and quantities, data formats, communications protocols and standards (hardware and software), control interfaces, and other aspects of integration with the plant control system. The Control Systems Supervisor shall document and resolve interface issues among the Contractor's organization, and for items irresolvable within the organization develop explicit Requests for Information (RFI's). RFI's shall include specific suggestions as to options and recommendations for resolution.
 - 3. Review and coordinate interconnection including control wiring, signal wiring, and communications interconnection among systems, devices, and sources of supply. This includes devices and systems installed under this project, as well as existing systems with which this project interfaces.
 - 4. Participate in workshops.
 - 5. Develop and/or review each submittal and RFI relating to instrumentation and controls.
 - 6. Supervise instrumentation and controls-related field investigations and development of submittals.
 - 7. Coordinate instrument and process control ranges and setpoints. Review instrument and configuration submittals and test procedures for these items, and coordinate among disciplines. Supervise selection of instrument options and ranges, mounting heights, and zero and span settings. Supervise development of preliminary instrument datasheets, and following plant startup supervise issuance of comprehensive instrument "as-built" settings.
 - 8. Review each applicable schedule, submittal, RFI, test procedure, test results, change, and other documents which include any instrumentation and/or controls to be transmitted to the Owner (regardless of where specified), and shall include with that transmittal a declaration such as the following.

"I, _____, have reviewed the accompanying documentation and find that it is in conformance with the requirements of the Contract Documents. I further attest that the signal interfaces and senses/ranges have been coordinated among devices and systems, that the functional requirements are met, that the physical characteristics and installations are coordinated and are suitable for the application, and that interconnection has been coordinated."
 - 9. Prior to submissions, review test plans and results associated with the control systems, including package systems with hardwired interfaces or networked interfaces. The Control Systems Supervisor shall provide a written statement similar to that above, to be

included with each submittal, that the test plans and results have been fully reviewed and are in conformance with the requirements of the contract documents.

10. Participate in all project testing and training activities as described elsewhere in the Specifications.
11. Take the lead in all aspects of startup planning which involve electrical, instrumentation, controls, programmed systems, and integration among existing/new systems and packages. Contribute to Contractor-specified deliverables. Account for outages and downtime limitations.
12. Supervise startup of instrumentation and control systems, regardless of where specified.
13. Supervise unwitnessed and witnessed factory and field testing of instrumentation and control systems.
14. Coordinate integration work with the existing plant control system.
15. Take overall responsibility/leadership for activities of the IS specified herein.

1.10 WORKSHOPS

- A. Refer to Section 013100 – Project management and Coordination. Prepare for, conduct, and contribute to recordkeeping for workshops pertaining to control systems

1.11 SUMMARY OF RESPONSIBILITIES

- A. This Article summarizes selected responsibilities associated with instrumentation and control for process systems, with emphasis on startup and testing. All specified requirements apply, regardless of whether they are listed below. The purpose is to draw attention to certain joint and coordination responsibilities.

Work Item	Where Specified	Where Executed		Responsible Parties	
		Factory	Field	Contractor's Organization	Owner's Programmer
Factory Testing of I&C Systems:					
FAT (unwitnessed)	409000	✓		✓	
FAT (witnessed)	409000	✓		✓	Participate in automated testing.
Factory Testing of Networked Motor Control:					
MCT (unwitnessed)	260000	✓		✓	
MCT (witnessed)	260000	✓		✓	✓
Factory Testing of Packages/Equipment:					
As specified	409000		✓	✓	
Precommissioning Tests:					
EPSET	017500		✓	✓	
ORT's	Various		✓	✓	

Work Item	Where Specified	Where Executed		Responsible Parties	
		Factory	Field	Contractor's Organization	Owner's Programmer
Commissioning Tests:					
FAT's	Various		✓	✓	Participate in automated testing.
RAT	017500		✓	✓	
Test Planning And Procedures:					
Factory Test Procedures	Various			✓	Automation insert for selected items.
Field Test Procedures	Various			✓	Automation inserts for selected items.

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: Type the type of facility this is for such as "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.

2.4 SPECIAL TOOLS

- A. The IS shall furnish a priced list of special tools required to calibrate and maintain the instrumentation provided. The Owner and Engineer will select which tools are to be purchased and the IS will supply them at the prices listed.
- B. In addition to the IS proposed special tools, the IS shall furnish the following:
 - 1. Fluke 789 Portable Process Meter, no equal.
 - 2. Fluke 726 Precision Multifunction Process Calibrator, no equal.
- C. Special tools shall be delivered to the Owner before startup commences.

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. Chlorine Analyzers
3. pH Analyzers
4. ORP Analyzers
5. Dissolved Oxygen Analyzers

- 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. The test location shall be within 20 driving miles of the project site. Equipment shall include the cabinets, special control systems, networked devices, and other pertinent systems and devices.
- B. The IS shall develop and submit a FAT Plan and Procedure Document within 10 days of the FAT. IS-developed FAT procedures shall provide a complete framework for testing and control panel hardware and PLC/supervisory system software functions. Test procedures for software functions will be provided by the Owner's Programmer. 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.
 - 4. Placeholders for automaton testing, on a loop-by-loop basis. The IS shall use the Contract Control Descriptions, amended by workshop results, as the basis.
- 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. Test procedures shall be submitted in advance of testing. Allow for two submittal rounds in scheduling.
- E. Provide no less than 20 days' advance notice of any test, and adjust the schedule within reason to accommodate others' schedules
- F. Except for test steps requiring participation by the Owner's Programmer, the FAT shall be planned and executed unwitnessed, prior to scheduling the witnessed FAT. Test results shall be submitted in advance of conducting the test witnessed. For unwitnessed verification of signals

from the physical environment to within the programmed environment, the IS shall monitor states within the PLC's or use other IS-developed means to prove continuity.

- G. The purpose of the FAT is not only verification of functionality of all Contractor-furnished automation, but it will also comprise a forum for factory testing Owner-furnished programming, and identification of Owner-desired changes to that programming in advance of fieldwork. The Contractor shall allow the following in support of those goals:
1. Provide physical space, power, and network connections for SCADA servers which will be Owner-furnished for testing purposes. Network connections shall include those with the control network, plus Internet access for general use and testing of alarm notification
 2. Allow in the schedule, 1 day for setup by the Owner's Programmer, in advance of the witnessed FAT.
 3. The FAT schedule shall allow adequate hours for execution of the scope of testing specified herein, plus allow for the following dedicated to testing and demonstration of programmed supervisory and PLC functions:
 - a. Eight (8) days total for testing of automation, including District witnessing.
 - b. Allow 3 days for changes by the Owner's Programmer, for programming corrections and execution of Owner-desired changes.
 - c. Allow 3 days for retesting.
 - d. Any time for Contractor corrections/fixes are in addition to the intervals above.
 4. Section 260000 includes requirements for Motor Control Testing (MCT) whose purpose is to validate in the factory environment the networked interfaces. The MCT can be combined with the FAT, at the Contractor's discretion, or conducted separately if test location(s), project delivery schedules so require. If the MCT is to be combined, then the durations specified for the MCT shall be appended to the FAT durations for planning and scheduling.
- H. The Owner's Programmer may choose to include in the FAT additional PLC's as proxies for existing Plant PLC's, to prove out in a factory environment the PLC-to-PLC handshaking and interlocking. The IS shall accommodate such a request, and allow for up to these additional PLC's (likely the two spare PLC's plus one more Owner-furnished PLC). Provide power and network connections. Testing of the additional PLC's will be the subject of the witnessed FAT, and configuring and simulation of values within those PLC's will be the responsibility of the Owner's Programmer.
- I. 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. Control Loop testing of Owner-selected equipment specified in Volume 3, Appendix A, shall include the equipment manufacturers programmer on site.

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 insure 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.
- F. Section 017419 includes Functional Acceptance Testing (FATC) which will generally call for participation by the Owner's Programmer. No fewer than 3 working days prior to an FATC which requires participation by the Owner's Programmer, the Control System's Supervisor shall issue a written certification that all instruments, equipment, and systems have been started up, are operable, ORT's are complete, and are ready to be put under full PLC monitoring and control. Exceptions, if any, shall be explicitly noted. If the exceptions are too great in the judgment of the Owner's Representatives, testing shall be delayed and the Contractor shall complete the missing work

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 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

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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. Modbus RTU (Two-Wire RS-485)
- 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. Flanged Large Diaphragm Seals

1. Flanged type diaphragm seals shall be used where clogging and/or high accuracy is required. The flanged housing shall be constructed of 316SS.
2. The diaphragm seal shall consist of a flange with flush or extended diaphragm such that the diaphragm surface is flush with the walls of the pipe surface. It shall have a direct mount, coplanar, welded connection for connection of the pressure sensor to the seal.
3. 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. Acceptable Manufacturers
 - a. Rosemount Series 1199.
 - b. Or Approved Equal.

D. 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. Ashcroft model 80.
 - b. Or Approved Equal.

E. 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 degree 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. Rosemount 2051.
 - b. Or Approved Equal.

F. 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. Ashcoft Series B (Gauge) and D (Differential).
 - b. Or Approved Equal.

G. 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. Ashcroft 1279.
 - b. 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 degree 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)
 - b. RTD only insertion assemblies
 - 1) Rosemount Series 78.
 - 2) Or Approved Equal.
 - c. Sensor and Transmitter Assemblies
 - 1) Rosemount 3144P.
 - 2) Or Approved Equal.

C. Temperature Gauges

1. Thermometers shall have be a 7-inch vertical column with a single direct-reading scale and scale as indicated. Each shall be rust and corrosion-resistant with a leak-proof, hermetically sealed 316 stainless steel housing. The sensing element shall be silicone dampened for vibration resistance. Stem length shall be the maximum standard size compatible with the piping or vessel but shall not exceed 9-inches. Dial shall be adjustable 360 degrees around the stem axis and tiltable to 90 degrees from vertical to obtain the best viewing angle. Accuracy shall be plus or minus 1 percent of range. Each thermometer shall be provided with a thermowell.

2. Acceptable Manufacturers
 - a. Wika Model TI.901.
 - b. 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

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. Modbus RTU (Two-Wire RS-485)
- 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.
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. Krohne VA40 Series.

- b. Dwyer UV 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) Fluid Components International (FCI) FLT93 Series.
 - 2) Sierra Instruments Innova-Switch Series.
 - 3) Or Approved Equal.

C. 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.

D. INSERTION THERMAL MASS FLOW METERS

1. Materials

- a. All mounting hardware shall be 316 stainless steel, the instrument enclosure and the spool mag shall be rated NEMA 4X
2. Design and Fabrication
- a. Velocity Range: 0-18,000 SFPM (300 SFPS), air at standard conditions of 25°C and 760 mmHg.
 - b. Velocity Measurement Accuracy: $\pm 2\%$ of reading from 10 to 100% of calibrated range.
 - c. Output 4-20ma signal proportional to flow rate. 700 ohms maximum resistance.
 - d. Power Supply 18 to 30 VDC
 - e. Repeatability: 0.25% or better.
 - f. Process Temperature Rating: -10°C to +120°C.
 - g. Process Pressure Rating: 150 PSIG.
 - h. Sensor Material: 316L Stainless Steel, all welded construction.
 - i. Sensor Support Material: 316L Stainless Steel all-welded construction.
 - j. Insertion Length: Per manufacturer's recommendations.
 - k. Process Line Sizes: 3" pipe and larger.
 - l. Sensor Electronics Enclosure: NEMA 4X, Class I, Div. 1, Groups B, C, D:
 - m. Sensor Enclosure Temperature Rating: -20°C to +50°C.
 - n. Process Connection: 316 Stainless Steel Compression Fitting to fit 1" FNPT Fitting on pipe (by customer).
 - o. Field Wiring: 1 pair of twisted and shielded 14-18 gauge wire having a maximum loop resistance of 4 ohms.
 - p. Safety approvals: Non-incentive: Class I, Div.2, GPS A,B,C,D,T5;CSA pending; Explosion-proof: Class I, Div. I, GPS B,C,D,T4, CSA pending; Flameproof: Eex d IIC T4; CENELEC pending.
3. Acceptable Manufacturers
- a. Fluid Component International ST98 Series with Display.
 - b. Or Approved Equal.

2.4 LEVEL PROCESS MEASUREMENT DEVICES

A. 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.

B. 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.

C. 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 1/2" threads and shall be suspended in the wet well by 1/2" stainless steel conduit.
6. Acceptable Manufacturers
 - a. KPSI model 750.
 - b. Or Approved Equal.

D. 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. Rosemount model 3051L with model 1199 diaphragm seal.
 - b. Or Approved Equal.

E. 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); Hydorranger 200 (remote transmitter) with XPS-15 or greater (transducer).
 - b. Or Approved Equal.

2.5 TURBIDITY PROCESS MEASUREMENT DEVICES

- A. Each turbidity 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 Turbidity 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 housing.
 2. The turbidity sensor shall meet the performance criteria of the U.S. Environment Protection Agency in Method 180.1, making it suitable for regulatory reporting.
 3. The sensor shall utilize a light source that directs light through the process water to a submerged photocell which detects the amount of light that passes through the water.
 4. Allowed to be installed in liquids whose temperatures are 32 to 122°F.
 5. The sensor shall have a measuring range of 0 to 100 NTU.
 6. Shall not require sample conditioning or electrolyte solutions.
- C. Acceptable Manufacturers:
 1. Hach model TU5300 Turbidity System with flow sensor, automatic cleaning module and SC200 or SC1000 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 409123

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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 $(\text{current I/O} + \text{future I/O}) * 120\%$. 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
 - 1. Allen Bradley Compact Logix
 - 2. Allen-Bradley ControLogix

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 the CompactLogix L3 or L4 Series

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.
- B. Ethernet ports shall be setup to communicate with the Allen-Bradley Ethernet/IP protocol.
- C. 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 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. Two spare processors for each type of PLC processor supplied for the project.
 2. Two spare I/O cards for every type of I/O card supplied for the project.
 3. Two spare PLC power supplies for every type supplied for the project.
 4. Two spare network adapters for each type of network adapter supplied for the project.
 5. Two spare bases of each type supplied, for rack-style PLC's.
- B. The Contactor shall ship to the District's Programmer, one of each of the items above, for use in program development. While in the possession of the District's Programmer, the Programmer

will be responsible for properly handling and protecting the components. In the event of a warranty failure, the Contractor shall cooperate in effecting a warranty claim.

- C. The parts shipped to the District's Programmer shall be provided no later than 90 days from Contract NTP.
- D. The remainder of the spares shall be kept in the Contractor's possession and be available throughout the commissioning process, should failures or other circumstances require the parts.

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. 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. Screw driver 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. Hand written 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. Hand written 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 a 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 as 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. UPS shall have dry contact signals that shall be connected to the PLC. Points shall be the following:
 - a. UPS on Battery Backup Power
 - b. UPS Fail
 - c. UPS on Primary Power
7. Acceptable Manufacturers
 - a. APC Smart-UPS XL 1000VA USB & Serial 120V with Dry Contact I/O SmartSlot Card AP9613

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: $\pm 1\%$ 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. 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. 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 bases with relays which plug into the base. Bases shall have screw-type connections.
6. Relays shall have an LED indicating when the relay 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. Allen-Bradley 700H 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 do 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) Pfannenbergl.
 - 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) Pfannenbergl.
 - 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 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 for PLC’s specified in Section 409000 will be by the District’s Programmer.

2.2 OIT PROGRAMMING REQUIREMENTS

- A. All OIT programming is to be provided by the equipment vendors. Vendors shall coordinate and comply with District standards for tagging and communications. Vendors shall provide configurations software and the resulting applications unlocked (no password protection) at project conclusion.

2.3 SCADA SYSTEM PROGRAMMING REQUIREMENTS

- A. SCADA system programming will be by the District's Programmer.

2.4 COMMON CONTROL FUNCTIONS

- A. Common functions that are generally applicable to all loops or to many similar loops are described below. These functions are not repeated in the descriptions for each individual control strategy. The following general control system functions shall be provided:

1. All equipment motors will have FAIL TO START and FAIL TO STOP alarms. Once the start control criteria are met a START/STOP COMMAND will be generated and the motor should start. Once the START/STOP COMMAND has been issued the FAIL TO START ELAPSED TIME will start. The PLC will expect to see a RUN INDICATION before the Fail to start Timer has reached the FAIL TO START TIME DELAY SET POINT. Failure to receive the Run Indication in the allotted time will trigger a FAIL TO START alarm. Once the stop control criteria are met the START/STOP COMMAND will be removed and the motor should stop. Once the Start/Stop Command has been removed the FAIL TO STOP ELAPSED TIME will start. The PLC will expect to lose the Run Indication before the Fail to Stop Timer has reached the FAIL TO STOP TIME DELAY SET POINT. Failure to lose the Run Indication in the allotted time will trigger a FAIL TO STOP alarm. The FAIL TO STOP and FAIL TO START alarms may only be reset by the HMI ALARM RESET pushbutton on the HMI. The delay set points will accept values from 0-9999 seconds.
2. All motors that are controlled by VFD's will have SPEED CONTROL FAILURE alarms. The SPEED CONTROL and SPEED CONTROL INDICATION will be compared once the Run Indication has been received. The two values must be within the SPEED DEVIATION SET POINT or a SPEED CONTROL FAILURE alarm will be generated. This alarm may only be reset by the HMI ALARM RESET pushbutton on the HMI. The SPEED DEVIATION SET POINT will accept values from 0-100%.
3. All valve motors with Open and Closed indication will have the following. Once the Open pushbutton is selected an OPEN COMMAND will be generated and the motor should run in the open direction. Once the Open Command has been issued the FAIL TO OPEN ELAPSED TIME will start. The PLC will expect to see a VALVE OPENED INDICATION before the Fail to Open Timer has reached the FAIL TO OPEN TIME DELAY SET POINT. Failure to receive the Open Indication in the allotted time will trigger a FAIL TO OPEN alarm. Once the Close pushbutton is selected a CLOSE COMMAND will be generated and the motor should run in the close direction. Once the Close Command has been issued the FAIL TO CLOSE ELAPSED TIME will start. The PLC will expect to see a VALVE CLOSED INDICATION before the Fail to Close Timer

has reached the FAIL TO CLOSE TIME DELAY SET POINT. Failure to receive the Closed Indication in the allotted time will trigger a FAIL TO CLOSE alarm. The FAIL TO CLOSE and FAIL TO OPEN alarms may only be reset by the HMI ALARM RESET pushbutton on the HMI. The delay set points will accept values from 0-9999 seconds.

4. When a motor generates an overload or VFD Fail Indication input a FAIL INDICATION alarm will be generated.
5. All modulating valves and dampers will have POSITION CONTROL FAILURE alarms. The POSITION CONTROL and POSITION INDICATION will be compared. The two values must be within the POSITION DEVIATION SET POINT or a POSITION CONTROL FAILURE alarm will be generated. This alarm may only be reset by the HMI ALARM RESET pushbutton on the HMI. The POSITION DEVIATION SET POINT will accept values from 0-100%.
6. All PID control functions (P, PI, and PID) shall be provided with standard analog controller functions and operator interfaces including, but not limited to, the following:
 - a. AUTO/MANUAL mode selection: In AUTO, the output of controller shall be based on the PID control calculation. In MANUAL, the output of the controller shall be operator adjustable. Transfer between operational modes shall be bumpless.
 - b. LOCAL/REMOTE set point selection: In LOCAL, the set point shall be operator adjustable from the equipment. In REMOTE, the set point shall be adjustable from a REMOTE set point input.
 - c. Set point, process variable, and controller output shall be displayed.
 - d. Provisions shall be included to prevent reset windup.
7. Cascaded loop control shall make use of two PID loops in series. The output of the first loop shall be the set point for the second loop. All requirements of PID loops apply to Cascaded Loops.
8. For all chemical storage tanks, the SCADA system shall calculate volume, amount used per shift, and amount used per day.
9. All chemical feeders shall be immediately restarted following restoration of power – either from the utility or the generator.
10. Analog Alarms – Where indicated analog alarms shall be setup where an alarm is generated when the analog value exceeds (typically for a high alarm) or falls below (typically for a low alarm) an operator adjustable set point for an operator adjustable amount of time. Once an alarm has been generated, it shall be latched and may only be cleared when the analog value is no longer out of range and the operator presses an alarm reset pushbutton on the HMI.
11. Instrument Failure – Each instrument that is monitored by a 4-20mA analog loop shall have an alarm generated if its signal falls below 3.5 mA or rises above 20.5 mA. This alarm shall be latched and shall require the operator to press an alarm reset pushbutton on the HMI.
12. SCADA Manual – All equipment that is controlled by a PLC shall have a supervisory manual mode unless otherwise indicated on the individual control strategy. In this mode

the Operator will be able to start and stop/open or close the equipment from the HMI with pushbuttons and indicate visually that the equipment is in Supervisory Manual Mode. If there is a VFD they will be able to set the VFD speed. If there is a valve position the operator shall be able to manually set the valve position. This mode is entered by selecting “Manual” on the HMI for the specific piece of equipment. Unless otherwise noted equipment running in Manual Mode will not restart automatically if shut down due to power outage or other alarms.

13. Pump Rotation – Pump rotation for groups of 2 or more shall rotate based on an operator adjustable interval in hours. Pump rotation shall only occur between the Lead and Lag pumps. If there are more than two pumps the third pump is not included in the automatic rotation until it is placed into the Lead or Lag position by an operator. Operators shall be able to manually manipulate pump positions at any time as well as the rotation on an interval. Naming of pumps shall be as follows:
 - a. Lead
 - b. Lag1
 - c. Lag2

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 409635.001 – SLUDGE STORAGE BASIN MIXING & DISCHARGE PUMPS

PART 1 - AREA OVERVIEW

- 1.1 PROCESS & INSTRUMENTATION DIAGRAM: PI-09
- 1.2 PROCESS DESCRIPTION: The Primary Pump Station facilitates the flow of RAS and Primary Clarifier effluent through the anoxic and aeration basins.
- 1.3 ASSOCIATED EQUIPMENT:
 - A. 63-ME-2300 – Sludge Storage Basin Mixer
 - B. 63-P-1100 – Sludge Storage Discharge Pump 1
 - C. 23-P-2100 – Sludge Storage Discharge Pump 2
- 1.4 ASSOCIATED INSTRUMENTATION:
 - A. Sludge Storage Basin Level Transmitter – 63-LT-2100
 - B. Sludge Storage Basin High Level Switch – 63-LSH-2100
 - C. Sludge Storage Basin High Low Level Switch – 63-LSL-2100
 - D. Sludge Storage Discharge Pump 1 High Temp Switch – 63-TSH-1100
 - E. Sludge Storage Discharge Pump 1 Pressure Transmitter – 63-PT-1100
 - F. Sludge Storage Discharge Pump 2 High Temp Switch – 63-TSH-2100
 - G. Sludge Storage Discharge Pump 2 Pressure Transmitter – 63-PT-2100
 - H. Sludge Storage Discharge Flow – 63-FIT-2200
- 1.5 SYSTEM PROGRAMMING: Owner’s Programmer

PART 2 - CONTROLS

- 2.1 HARDWIRED INTERLOCKS/SHUTDOWNS: **There are no** hardwired interlocks associated with this system.
- 2.2 SOFTWARE INTERLOCKS/SHUTDOWNS: **The following** software interlocks **are** associated with this system.
 - A. Low Level Alarm 63-LT-2100 reset by 63-LSH-2100
 - B. Low Low Level Alarm 63-LSL-2100

- 2.3 SYSTEM CONTROLS: The following controls are associated with this system.
- A. **LOCAL MANUAL Control Mode:** The following LOCAL MANUAL controls are associated with this system.
1. **Hand/Off/Remote** - The pumps and mixer may be locally started when the HOR switch is placed in the HAND position. The equipment may be stopped by moving the HOR switch to the OFF position.
 2. **POT** – When in the HAND position on the HOR switch the speed of the pumps can be controlled manually by using the POT.
- B. **LOCAL AUTO Control Mode:** There are no LOCAL AUTO controls associated with this system.
- C. **SCADA MANUAL Control Mode:** As defined in 409635 2.4 A 12.
- D. **SCADA AUTO Control Mode:** The following SCADA AUTO controls are associated with this system.
1. When the HOR switch is in the REMOTE position and the SCADA MANUAL/AUTO switch is in the AUTO position for any given pump, the equipment may be controlled automatically from SCADA.
 2. Level Measurement - The wet well has one level measurement device (63-LT-2100).
 3. **Pump Control** – The pumps shall operate based on one of two operator set point:
 - a. Flow Rate Based – operators can input a set flow rate. Active (lead) pump will adjust speed to maintain operator set flow rate based on feedback from the sludge discharge flow meter (63-FIT-2200).
 - b. Total Volume Based – Operators may set a target total volume to pump at a pre-selected pump speed. The lead pump will operate at the pre-selected speed until the target total volume is reached at which point the pump returns to standby/ready mode.
 4. Pumping will cease if the low low level alarm is activated.
 5. High Level Float – If the high level float is triggered the PLC will call for both pumps to run at 100% until the low float is triggered. This should also trigger flow from the WAS pumps (and WAS Thickener) to stop as well as flow from the other 2 sludge feed lines/pumps from the primary clarifiers.
 6. Pump Rotation - Pump rotation shall be handled via manual entry of set operating hours.
 7. Bypass Contactors - In the event of VFD failures Pumps 3 and 5 are equipped with bypass contactors to try and maintain flow through the plant. All staging and other operations shall continue as defined in this document.
 8. The mixer (63-ME-2300) will cease operation if Low Level alarm is reached, and will not start mixing again until level transmitter LT-2100 indicates level is above operator set minimum level.
 9. Pumps may alarm and cease operation of discharge pressure or high temperature switch is activated. Refer to pump supplier control recommendations.

END OF SECTION 409635.001

SECTION 432357 – PROGRESSIVE CAVITY PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies positive displacement progressing cavity pumps, complete with electric motors, and all specified appurtenances, as shown on the plans and specified herein.
- B. The pumping units shall be of the self-priming, positive displacement, progressing cavity type specifically designed for pumping bulk liquid or polymer solutions, as specified, and/or waste water sludges.
- C. Pumps shall handle required suction lift as detailed in the design drawing applications. Supplier to confirm suitability of listed equipment for installation application.

1.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Sludge handling pumps shall be specifically designed and selected for continuous duty pumping for the following services:

Location	Material	Fluid Temperature
Thickened Sludge	Thickened Sludge (Up to 8%)	Ambient

- B. 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.
- C. The pumps, along with associated drive appurtenances, shall be mounted on common fabricated steel baseplates.
- D. Manufacturers must currently have installations for the same liquids and of the same model pump unit, in service for a minimum of three years.
- E. All equipment shall be designed and built for 24-hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation, and without excessive vibration or strain.
- F. The pumping units required under this section shall be complete. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the service to be performed. Ample room for inspection, repairs and adjustment shall be provided.
- G. Stainless steel nameplates giving the name of the Manufacturer, the pump serial number and material code and all other pertinent data shall be attached to each pump, motor, and control panel.

- H. All working parts of the pumps and motors, such as bearings, wearing rings, shaft, sleeves, etc., shall be standard dimensions built to limit gauges or formed to templates, such that parts will be interchangeable between like units and such that the Owner may, at any time in the future, obtain replacement and repair parts for those furnished in the original machines.
- I. The nameplate ratings of the motors shall not be exceeded, nor shall the design service factor be reduced when the pump is operating at any point on its characteristic curve at maximum speed.
- J. Mechanical equipment, including drives and electric motors shall be supplied and installed in accordance with applicable OSHA regulations. The noise level of motors, unless otherwise noted, shall not exceed 85 dBA measured 3 meters from the unit under free field conditions while operating on utility power.
- K. All lubrication fittings shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards.
- L. Pumps to be installed **OUTDOORS** and all components shall be suitable for outdoor, exposed conditions.

1.3 RELATED SECTIONS

- A. Common Motor Requirements for Equipment, Section 220513.

PART 2 - SUBMITTALS

2.1 GENERAL

- A. Product Data: Submit manufacturer's technical product data, including installation instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings, indicating dimensions, weights, materials, and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data and spare parts list. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.
- D. Performance Curves: Submit predicted performance curves developed for the specific application. Performance curves shall plot speed, capacity, head, and horsepower required for the specified operating range.
- E. 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.

2.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of progressive cavity pumps, of types and sizes required, whose products have been in satisfactory use in similar service.

2.3 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.

<u>Reference</u>	<u>Title</u>
AGMA 6010-E-88	Spur, Helical, Herringbone, and Bevel Enclosed Drive
AGMA 6019-E-89	Gear Motors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears
AGMA 6023-A88	Design Manual for Enclosed Epicyclic Gear Drives

2.4 DESIGN CRITERIA

- A. The required performance and design criteria for the pump(s) is listed in the Drawings.

PART 3 - PRODUCTS

3.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
1. Seepex
 2. Or equal.

3.2 MATERIALS

Component	Material - Sludge Pumps
Rotor	Alloy Steel (316 SS) – Duktal Coated (1250 Vickers hardness)
Stator	Buna N
Pump Body	Cast iron
Shaft Sealing	SEEPEX single bellows OR Packing

3.3 EQUIPMENT

- A. Rotor and stator: Each pump shall be a one (two, four, eight) stage design employing a convoluted rotor operating in a similarly convoluted stator. The convolutions shall be configured to form a cavity between the rotor and stator, which shall progress from the pump's inlet to discharge port with the operation of the rotor. The fit between the rotor and stator at the point of contact shall compress the stator material sufficiently to form a seal and to prevent

leakage from the discharge back to the inlet end of the pumping chamber. The stator shall be molded with a seal integral to the stator elastomer preventing the metal stator tube and the bonding agent from the elastomer from contacting the pumped liquid. Gaskets or "O" rings may not be used to form this seal. Stators for sludge pumps shall have Buna elastomer. The sludge pump rotors shall be constructed of Alloy Steel (316 SS). Additionally, the sludge pump rotors shall have a chromium nitride coating (Duktil) with a hardness of 1250 Vickers and a minimum thickness of (.0108"). Hard chrome plating or ceramic coatings are not acceptable due to the ease at which this coating will crack and the lack of diffusion into the rotor base metal.

- B. Rotor and drive train: The rotor drive train shall be warranted for a minimum of one (1) year from acceptance and shall consist of the following:
1. Each pump rotor shall be driven through a positively sealed and lubricated pin joint. The pin joint shall have replaceable bushings, constructed of air-hardened tool steel of 57-60 HRc, in the rotor head and coupling rod. The pin shall be constructed of high speed steel, air hardened to 60-65 HRc. The joint shall be grease lubricated with a high temperature (450° F), PTFE filled synthetic grease, covered with Buna N sleeve and positively sealed with hose clamps constructed of 304 stainless steel. A stainless steel shell shall cover the rotor side universal joint assembly to protect the elastomer sleeve from being damaged by tramp metals or glass. The universal joints shall carry a separate warranty of 10,000 operating hours. This warranty shall be unconditional in regards to damage or wear.
 2. Stators shall be replaceable without dismantling the pump suction or discharge flanges or any associated piping. Pumps that require additional space for axial/horizontal removal of the stator shall not be allowed. Stator designs shall additionally incorporate a retensioning feature to compensate for wear in lieu of increasing pump speed. Stator designs shall permit inspection of and access to the cavities for the removal blockages without removing the rotor from the pump.
 3. Rotors shall be replaceable without dismantling the pump suction or discharge flanges or associated piping. Pumps that require additional space for axial/horizontal removal of the rotor shall not be allowed. The rotor design shall include provisions so that the rotor replacement does not require the disassembly of either universal joint.
- C. Casing: A 150-pound (ANSI B16.5) flanged connection shall be provided at both the inlet and discharge ports. The suction and discharge casings shall each be provided with a 3/8-inch (or larger) tap to permit installation of pressure instruments.
- D. Bearings: Each pump shall be provided with oil lubricated thrust and radial bearings, located in the gearmotor, designed for all loads imposed by the specified service.
- E. Shaft sealing: Shaft shall be sealed using a single internal mechanical seal as specified. The shaft shall be solid through the sealing area, but of a two part design which allows the rotating unit to be removed from the pump without disassembly of the gearmotor bearings. Seal materials shall be solid silicon carbide faces with 316 stainless steel metal parts and viton (EPDM) elastomers.
1. Where required, a double mechanical seal shall be provided to maintain a seal at the minimum suction head, as indicated in Section 1.2.

- F. Motor and Drive Unit:

1. Gear motors or gear reducers shall be designed in accordance with AGMA 6019-E (Class II). Unless otherwise noted, motors shall be energy-efficient, TEFC motors.
 2. The pumps shall be variable frequency drive (VFD) controlled. The pump supplier shall be responsible for the provision of the fixed reduction between the motor and pump. The reduction ratio shall be that required to operate the pump at its maximum operating speed when the motor is operating at its nominal rated full speed as specified.
- G. Run dry protection: The stator shall be fitted with a sensor sleeve and thermistor sensor. A controller shall also be provided and shall be installed by the contractor in the motor control center. The controller shall monitor the stator temperature and activate a shutdown and alarm sequence if the stator temperature reaches the adjustable limit on the controller. The controller shall include a manual local and be capable of providing a future remote reset function. Input to the controller shall be 1x115VAC/60 Hz.
- H. Over pressure protection: Each pump unit shall be supplied with a silicone-filled isolation ring with a dual mounted gauge and single point pressure switch. The pressure ranges for the switch and gauge shall be selected specifically for each specified service. The isolation ring shall be mounted between ANSI flanges, be sized according to the discharge pipe as shown on the plans, and be constructed with a carbon steel body and fittings with a Buna sleeve. The switch shall be SPDT, NEMA 4X.

3.4 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 California 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

3.5 PRODUCT DATA

- A. The following information shall be provided in accordance with Section 13000.
1. Mill certifications confirming hardness of rotor.
 2. Applicable operation and maintenance information.
 3. Motor data.
 4. Installation certification form.
 5. Training certification form.

3.6 SPARE PARTS

- A. One set of special tools shall be provided to service the pumps. In addition, the following shall be provided for each pump size (as appropriate for type of drive provided):
 - 1 - stator assembly with TSE sensor sleeve
 - 1 - rotor
 - 1 - set universal joint assemblies
 - 1 - TSE controller
 - 1 – mechanical seal (packing)
- B. Standby components shall be tagged and stored.

PART 4 - EXECUTION

4.1 INSTALLATION

- A. The pumps shall be installed as specified and in accordance with manufacturer's written recommendations.
- B. Install 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.
- C. 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 TESTING

- A. After completion of installation, the pumps shall be completely tested to demonstrate compliance with operating requirements as specified. The services of the pump manufacturer's field service representative shall be provided for one (1) 8-hour day at site and at no additional cost to the owner for inspection, startup, acceptance and training.
- B. Prior to startup, each pump shall be contractor tested by bumping the motor to check for rotation and the incoming voltage shall be verified to comply with pump nameplate rating and motor requirements.
- C. After equipment has been contractor tested and the start-up has been successfully completed, the manufacturer's field service representative shall instruct the owner's personnel in the care, operation and adjustment of the equipment furnished.

4.3 STARTUP AND TRAINING

- A. Following completion of the installation the pump manufacturer shall provide the service of qualified representatives to verify proper installation and assist in the pump startup.
- B. Pump manufacturer shall provide qualified training and maintenance instruction to the Owner's maintenance personnel.

4.4 SUPPLIER QUALIFICATIONS AND QUALITY ASSURANCE

- A. The progressive cavity pumps shall be of a standard catalog product of a manufacturer regularly engaged in the production of this type of equipment that can show not less than five years of satisfactory performance for pumps of this type and size. The manufacturer shall have a factory authorized representative and repair facility in close proximity to the project site and which has been designated as such for at least ten years prior to project bid date and located within the state of California.
- B. The authorized manufacturer's representative shall have both in-house and field service technicians located within the state of California, factory qualified to work on supplied equipment with a minimum of ten years' experience in pump and control repair. No exceptions.

END OF SECTION 432357

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SECTION 433250 – AIR JET CHOPPER PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION OF THE WORK

- A. The CONTRACTOR shall furnish and install submersible air jet chopper pumps as specified herein and according to the plans and drawings.
- B. All parts shall be designed and proportioned for ample strength, stability, and stiffness for their intended purposes.
- C. Pump(s) shall be designed for submerged continuous-duty and be specifically intended to pump and agitate waste solids and thickened waste solids at heavy consistencies and to aerate the pumped liquid. Motors shall be rated for the classified area in which they will be located.
- D. Pump manufacturer shall be ISO 9001 certified.
- E. Motor(s) shall be the heavy-duty asynchronous speed type, as specified in this section.

PART 2 - PRODUCTS

2.1 Operation Conditions and Requirements

- 1. Type of tank: Primary Sludge, WAS, and thickened WAS in a Scum Equalization Tank
- 2. Number of tanks: 1
- 3. Tank dimensions, [ft.]: 20' × 20' × 1' to 13' swd (see design drawings)
- 4. Type of liquid: Primary Sludge, Waste-Activated Sludge, Thickened Waste Activated Sludge, and Scum
- 5. Dry matter solids content, [%]: 1.5% up to 3%
- 6. Liquid temperature, [°F]: Ambient
- 7. Required Oxygen Transfer per tank, SOTR, [lbs/day]: 432
- 8. Motor size, [HP]: As Required – see equipment schedule in design drawings
- 9. Power supply, [phases/voltage/hertz]: 3ph/460V/60Hz
- 10. Classification: Class 1, Division 1

2.2 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the requirements of this specification, air jet chopper pumps manufactured by the following are acceptable:
 - 1. Landia, Inc. (DG-I Submersible AirJet Chopper)
 - 2. Approved Equal

2.3 PUMP DESIGN

A. Pump Casing

1. Casing shall be of gray cast iron AISI A48-40B with all water passages to be smooth, and free of blowholes and imperfections that inhibit good flow characteristics. Fabricated casings will not be accepted.
2. Front and back suction plates shall be machined such that all solids are directed away from the seal area. In addition, back pump out vanes on the impeller shall eliminate debris from collecting around the seal area.
3. An anti-clog bar shall be mounted on the pump volute in conjunction with the stationary knives. The impeller shall incorporate a raised vane tip, which, in conjunction with the anti-clog bar, will eliminate stringy material from clogging at the impeller eye. Pump designs that require a cleanout plug in the pump casing shall not be accepted.

B. Pump Assembly

1. All mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces, resulting in compression of the O-rings without requiring specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease, or other devices shall be used.

C. Chopping System

1. Chopping/maceration of solids shall be accomplished by the action of two rotating knives moving across one fixed knife (alternatively three fixed knives) mounted by the pump inlet external of the pump casing. The chopping system shall be designed to prevent the pump inlet from clogging
2. Rotating and fixed knives shall be easily replaceable without the use of special tools or requirement of pump disassembly.
3. Fixed and rotating knives shall be of steel AISI A570 Gr.36 and heat-treated to 60 Rockwell C Hardness.

D. Impeller

1. Impeller shall be open type cast iron AISI A48-40B and dynamically balanced. The impeller shall be rigidly held in place with an impeller bolt and shall require no axial adjustments and no setscrews. Fabricated impellers shall not be acceptable.
2. The impeller shall not be required to assist in any chopping/macerating function. Pump designs that require the impeller to chop solids shall not be accepted.

E. Motor

1. The pump motor shall be submersible of the asynchronous speed type, housed in an air-filled, watertight chamber. The stator winding shall be insulated with moisture resistant Class F insulation, which shall resist temperatures of 315°F. The stator shall be dipped and baked three times in Class F varnish. The motor shall be designed for continuous-duty, capable of sustaining a maximum of 10 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. The motor shaft, delivered with the rotor as an integral part, shall be shaft steel AISI 4340. The stator housing shall be of gray cast iron AISI A48-40B.

2. The thermal sensors, embedded in the stator winding and wired into the pump control, shall monitor over temperature. These shall supplement the external motor over current protection located in the control panel.

F. Cable Entry

1. The cable entry shall be an integral part of the stator casing. The cable entry shall be composed of a conical cable holder with a flange bearing against a shoulder in the stator-casing opening. The cable entry cone shall be of gray cast iron AISI A48-40B. Sealing shall be accomplished by metal-to-metal contact between machined surfaces resulting in compression of the O-ring. The cable shall be cast into the cable entry cone providing a leak-proof, torque-free seal at the cable entrance. No terminal board in the motor is required.

G. Air Ejector System

1. Aeration shall be accomplished by means of air induction through ejectors permanently mounted on the tank floor. The pump discharge shall connect to the ejectors via a vertical slide motion when lowering the pump on its guide pipe. The liquid shall accomplish the mixing of the air and liquid as it is pumped through the nozzle chamber increasing the liquid velocity. This creates a consistent negative pressure in the ejector system resulting in air being drawn down through the air suction pipe. The turbulent mixture of air and liquid as it passes through the ejector nozzle is then flushed out through the ejector by means of high pressure.
2. One complete air ejector system shall be furnished per pump. The air ejector system shall be constructed of AISI 304 stainless steel. The pump manufacturer to ensure compliance shall manufacture the complete air ejector system.

H. Seals

1. Each pump shall be provided with a double mechanical seal system, each containing one stationary silicon carbide ring and one rotating silicon carbide part running in the oil for cooling and lubrication. They shall be mounted on the motor shaft to isolate the oil chamber from the dry motor stator housing and the medium from the oil chamber. The impeller and pump casing back plate design, both having pump out vanes to reduce seal area pressure and to prevent any build-up of solids between impeller and pump casing, shall protect the outer mechanical seal.
2. Each pump shall be provided with an oil chamber for the shaft sealing system. Drains and inspection plugs shall be provided with positive anti-leak seal and shall be accessible from the outside.
3. Mechanical seals shall not require a lubrication monitoring system to ensure reliability.

I. Shaft and bearings

1. The pump motor shaft shall rotate on two permanently lubricated bearings. The inner and outer bearing shall be single row, deep-groove ball bearings calculated for an L-10 life of 100,000 hours at full load.
2. The motor shaft shall be Alloy Steel AISI 4340.
3. The impeller shall be directly attached to the motor shaft. No shaft coupling shall be required.

2.4 ACCESSORIES:

A. Guide Rail Assembly

1. A guide rail assembly shall be used to support each pump during operation and to guide the units during installation and regular preventative maintenance inspection. The system shall consist of a bottom-bearing console, a stop bracket, a single square tube guide pipe, a fixing bracket and a guide holder assembly. All major components shall be constructed of AISI 304 stainless steel.
2. The bottom assembly shall be bolted to the floor of the tank and provide support for the guide rail and designed so the pump discharge will connect to the air ejectors when the pump is properly seated.
3. The upper guide holder assembly shall secure the system to the tank wall, platform, or under manhole/hatch/cover, as required by the application. It shall also provide the lateral support for the guide rail. The assembly shall contain a location to secure the electrical motor cable holder.

B. Crane Arm Assembly

1. A crane arm assembly shall be provided for each pump to raise and lower the unit for installation and service. It shall consist of a crane arm and a winch with stainless steel wire. The crane arm assembly shall be of stainless steel or hot dip galvanized steel. It shall be suitable for swinging the pump over the tank wall, platform or manhole and place it safely on the platform or on the ground outside the tank.

C. Fasteners

1. All fasteners shall be of AISI 316 stainless steel.
2. Manufacturer shall supply anchor bolt design calculations, signed and stamped by an engineer licensed in the State of Hawaii.

2.5 QUALITY ASSURANCE:

A. Factory Test: The Pump Manufacturer shall perform the following inspections and tests on each pump before shipment from the factory:

1. A balancing of the motor (rotor).
2. A dry run pump test to verify correct rotation and mechanical integrity. The entire unit is checked for vibration.
3. A Full Load Motor Test (run dry for 5 minutes at full load) to verify electrical data measurements. All electrical data shall be registered as part of documentation.
4. A submerged test of the pump where pump casing is exposed to an over pressure of 15 PSI.
5. A motor and cable insulation test for moisture content and insulation defects.
6. A final inspection of impeller, motor rating, and electrical connections for compliance with purchase order.
7. All inspections and tests shall be executed under ISO 9001 certification.
8. The pump performance shall be substantiated by a model test of each pump model and size. For pumps exceeding 60 HP each unit shall be tested in a pump test stand.

B. Manufacturer's Services:

1. Following completion of the installation the Pump Manufacturer shall provide a qualified representative to verify proper installation and assist in equipment startup and maintenance training for the Owner's personnel.

END OF SECTION 433250

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