Southside Water Reclamation Plant

REQUEST FOR INFORMATION

ROTARY DRUM THICKENER

DEADLINE FOR SUBMISSION OF INTENT TO PARTICIPATE AND QUALIFICATIONS STATEMENTS

2:00 PM (MST), JANUARY 5, 2017

ENGINEER:
INTENT TO PARTICIPATE

PLEASE RETURN THIS FORM BY EMAIL BY 2:00 P.M. MST ON JANUARY 5, 2017 TO:

Keli De Angelis Craig: telephone (505) 289-3009; email (kdeangelis-craig@ABCWUA.org)

The rotary drum thickener (RDT) system supplier who represents as an Offeror has received the Request for Information and we will submit our questionnaire by the required deadline of JANUARY 5, 2017.

☐ YES  ☐ NO

If response to above question is "NO," please provide reason: ________________________________

________________________________________

Please Print or Type

NAME OF ROTARY DRUM THICKENER SYSTEM SUPPLIER: ________________________________

NAME OF OFFEROR: _______________________________________________________________

OFFEROR'S COMPANY NAME: _______________________________________________________

OFFEROR'S COMPANY ADDRESS: ___________________________________________________

________________________________________

Sludge and Reuse Water Samples

Up to five gallons of unthickened waste activated sludge (UWAS) and reuse water may be collected by the Offerors submitting Proposals. These samples can be analyzed by the Offerors to determine thickening capability, identify optimal polymers, and determine polymer consumption. Reuse water will be used for polymer dilution and RDT operation. Potable water will not be made available for the demonstration testing.

Offeror shall be responsible for managing, transporting, and disposal of any samples collected from the site. Offeror shall dispose of all samples collected in accordance with all local, state, and federal guidelines. Offerors shall send their representative and bring their own sample containers to the Water Authority Southside Water Reclamation Plant (SWRP) located at 4201 Second Street SW, Albuquerque, New Mexico, 87105 on December 20, 2016 between the hours of 8:00 am and 2 pm (MST). Offeror shall contact Victoria Dery (Water Authority Project Manager) upon arrival at the plant at 505-289-3501 to make arrangements to collect the sample. The Water Authority will not furnish sample containers.

Please provide the name of the person to whom the UWAS sample will be provided.

NAME OF SAMPLE RECIPIENT: _______________________________________________________

Rotary Drum Thickener
Request for Information

1
GENERAL REQUIREMENTS

1.0 INTENT

1.1 The Albuquerque Bernalillo County Water Utility Authority ("Water Authority") is soliciting Requests for Information (RFI) to obtain performance information on Waste Activated Sludge (WAS) Mechanical Thickener Equipment (the "equipment") for the RDT Facility Design Project ("Project"). Water Authority is seeking information from interested firms and individuals, (hereinafter called "Offerors") to participate in a process to identify a rotary drum thickener manufacturer on which to base the design of a new Rotary Drum Thickener Facility.

1.2 The intent of this request is to physically test equipment performance, obtain value-based proposals, and identify reliable, high performing equipment that specifically meets the performance requirements and needs of the Water Authority.

1.3 Offerors are invited to submit proposals that detail the equipment the Offerors propose to supply and demonstrate the compliance of their firm and equipment with the requirements and specifications of this invitation.

1.4 If your company meets the Vendor Qualifications requirements identified in Section 6, you are invited to participate in this RFI. If your company does not choose to participate in this phase of the project, your equipment may not be considered during the design and construction phases.

1.5 Failure to provide the required information in strict accordance with the "GENERAL REQUIREMENTS" and the "INTENT TO PARTICIPATE" form, and the documents required by the RFI may result in your firm being deemed non-responsive and disqualified from the evaluation process.

1.6 Water Authority does not intend to directly purchase any equipment as a result of this RFI. The intent of this request is to identify a rotary drum thickener manufacturer on which to base the design of a new Rotary Drum Thickener Facility to be purchased and installed by a General Contractor at a later date. The General Contractor will be instructed to allocate funds for the purchase of the equipment within their construction bid or work order offer.

1.7 No Obligation: This RFI in no manner obligates the Water Authority to pursue any contractual relationship with an entity that submits a proposal. The Water Authority further reserves the right to cancel this RFI at any time deemed to be in its best interest.

1.8 All costs associated with demonstration piloting, unless stated otherwise herein, shall be the responsibility of the Offeror. This includes mobilization and demobilization of the equipment.
2.0 PROJECT DESCRIPTION

2.1 Water Authority will be implementing its Project at the SWRP. The Project includes the addition of an RDT Facility, installation of four new rotary drum thickeners to thicken unthickened waste activated sludge (UWAS) for disposal at digesters, and a polymer storage and feed system. The SWRP uses the Modified Lutzack-Ettinger process used for secondary treatment. The RDT will be processing UWAS from the final clarifiers that are part of this treatment system.

2.2 Water Authority has retained services of Carollo Engineers (the "Engineer") to perform general design and construction management services for the Project. Upon identification of the most advantageous equipment, the Engineer will complete final design based on the Offerors' specifications and prepare general construction bid or work order offer documents ("Contract Documents") with the intent of obtaining bids or work order offers and selecting a General Contractor to install the equipment and other related work. The equipment identified by this RFI will be included in the general construction bid or work order documents.

2.3 A preliminary equipment layout plan is included in Figure 1 (Appendix C) for information purposes only.

3.0 SCHEDULE

3.1 Upon receipt of this RFI and prior to scheduling the field demonstration, please complete and submit the INTENT TO PARTICIPATE form in accordance with the instructions on that form according to schedule. Electronic submittal is acceptable to Keli De Angelis Craig (email: kdeangelis-craig@ABCWUA.org).

3.2 Note that your response to the Vendor Qualifications Questionnaire (Section 6) must include all responses to questions, installation lists and references, supporting documentation and information, and forms required. Complete and submit the Vendor Qualifications Questionnaire according to schedule. Electronic submittal is acceptable to Keli De Angelis Craig (email: kdeangelis-craig@ABCWUA.org).

3.3 Following the on-site demonstration pilot operations, each Offeror must provide a Cost Proposal as part of their Proposal. As part of your Proposal, please also complete and submit all documents required by this RFI.

3.4 For Proposals to be considered, 5 copies must be received according to schedule at Albuquerque Bernalillo County Water Utility Authority, One Civic Plaza NW, Room 5027, Albuquerque, NM 87102. ATTENTION: Keli De Angelis Craig. Proposals received after the deadline will be placed in the file unopened and will not be considered. Proposals will be opened in a manner preventing disclosure of proposal respondents and the contents of the submissions to the extent allowable by law. Proposals will then be sent to the Water Authority-appointed Evaluation Committee for evaluation and final review.
3.5 **Schedule.** The RFI schedule is:

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue Invitation</td>
<td>week of December 11, 2016</td>
</tr>
<tr>
<td>Submit questions related to Intent to Participate and Vendor Qualification Questionnaire and Supporting Documentation by 2:00 pm MST</td>
<td>December 20, 2016</td>
</tr>
<tr>
<td>Issue addenda for the RFI</td>
<td>December 23, 2016</td>
</tr>
<tr>
<td>Submit Intent to Participate Form by 2:00 pm MST</td>
<td>January 5, 2017</td>
</tr>
<tr>
<td>Submit Vendor Qualification Questionnaire and Supporting Documentation by 2:00 pm MST</td>
<td>January 5, 2017</td>
</tr>
<tr>
<td>Contact Offeror’s References</td>
<td>January 6, 2017 to January 12, 2017</td>
</tr>
<tr>
<td>Issue invitation for Demonstration Testing to qualified Offerors by</td>
<td>January 23, 2017</td>
</tr>
<tr>
<td>Assign one week window for Demonstration Testing (randomly by Water Authority)</td>
<td>February 6-10, or February 13-17, or February 21-25, 2017 (if needed)</td>
</tr>
<tr>
<td>Submit final questions by 2:00 pm MST</td>
<td>February 23, 2017</td>
</tr>
<tr>
<td>Submit Proposal and Cost Proposal by 2:00 pm MST</td>
<td>March 2, 2017</td>
</tr>
</tbody>
</table>

3.6 Scores established by the Evaluation Committee will be made available to all participants.

4.0 **QUESTIONS**

4.1 Water Authority's designated procurement contact person for questions or additional information concerning the products and services specified in this Request for Information, or for additional information (i.e., submission deadline, forms required, etc.), is Keli De Angelis Craig: telephone (505) 289-3009; email (kdeangelis-craig@ABCWUA.org).

4.2 All questions requesting clarification or interpretation must be submitted in writing (e-mail) to the procurement contact according to the schedule. Questions received after that date may not be considered or receive a written response. Response to questions will be posted for all prospective Offerors to view. No additional information will be sent through email or fax. If the Water Authority decides that questions prompt the need for changes to the specification, an addendum will be issued and distributed to prospective Offerors.
5.0 TECHNICAL SPECIFICATIONS

5.1 Refer to Appendix A for the Pre-Procurement Technical Specifications.

6.0 VENDOR QUALIFICATIONS

6.1 Offerors must complete the Vendor Qualification Questionnaire included with this RFI. The Water Authority will review the responses to the Vendor Qualification Questionnaire and confirm eligibility for an onsite pilot demonstration. If your company does not meet the experience and qualifications required by the Vendor Qualification Questionnaire as determined by the Water Authority, your equipment will not be evaluated. Any affirmative responses to items 1-6 on the Vendor Qualification Questionnaire that do not include verifiable documentation will be considered a negative response.

6.2 Offerors must provide references to be contacted according to the schedule above. Provide references that will be available during this time period. The Engineer will make every effort to contact the Offeror's references within the time allotted schedule. Failure of the Engineer to contact the reference due to non-responsiveness or outdated contact information is not the responsibility of the Engineer and scores may be adversely affected.

6.3 Submit data proving compliance with the specified experience, installations, and references requirements. To demonstrate compliance with the installation and reference requirements, submit the following for each installation and reference:

6.3.1 Treatment plant name and location, including city and state.

6.3.2 General description of sludge being thickened (e.g. anaerobically digested blend of municipal primary and waste activated sludge).

6.3.3 Models and sizes of the RDTs installed.

6.3.4 Number of RDTs installed.

6.3.5 Year of installation.

6.3.6 Name, current telephone number, and current e-mail address for Water Authority contact person at treatment plant.

6.3.7 Name, current telephone number, and current e-mail address for design engineer contact person.

6.4 Provide information describing service and support centers that will provide service to the Water Authority. Describe the services provided at each service center, including each center's manufacturing, balancing, and rebuilding capabilities. Indicate the number of service personnel assigned to each service center that will provide service to the Southside Water Reclamation Plant. Indicate the training and qualifications for the service personnel that will provide service to the Southside Water Reclamation Plant. Provide typical response time for service calls, including time required for travel to the Southside Water Reclamation Plant, and the typical response time for spare parts delivery for all recommended spare parts.
7.0 DEMONSTRATION PIlotING

7.1 Offerors meeting requirements as stated in the Vendor Qualification Questionnaire will be invited to demonstrate the performance of their equipment at the Southside Water Reclamation Plant. Manufacturers that do not demonstrate the performance of their equipment may not be considered during the design and construction phases of the Project.

7.1.1 Offerors interested in demonstrating the performance of their equipment shall:

7.1.1.1 Confirm the schedule with the Water Authority's Engineer for delivery, testing, and removal of the demonstration skid.

7.1.1.2 Provide a complete and self-sustained RDT demonstration skid including polymer feed system with a RDT feed capacity of a full scale demonstration model of at least 100 gpm @ 0.8% solids. Provide the labor and equipment for the installation, operation, and removal of the demonstration skid.

7.1.1.3 Provide influent flowmeter and throttling valve for flow rates of 50, 75, and 100 gpm. Provide documentation that the flow meter was calibrated in the past 30 days. Conduct three trials with the Water Authority selected polymer Solenis Praestol K 120L flocculant at 50, 75, and 100 gpm unthickened sludge flow. The Water Authority will provide the Solenis Praestol K 120L polymer for field trials.

7.1.1.4 Conduct three trials with the Offeror selected polymer at 50, 75, and 100 gpm of unthickened sludge flow. Provide the name and contact information of the local supplier of the Offeror's selected polymer to be contacted by the Water Authority to determine polymer cost. The Offeror shall provide all of the required Offeror-selected polymer for field trials.

7.1.1.5 Submit safety data sheet (SDS) of Offeror's selected polymer prior to mobilizing for pilot demonstration testing.

7.1.1.6 Provide real time measurement of polymer usage by means of a recently calibrated metering pump (calibration within last 30 days).

7.1.1.7 Have 5 calendar days to demonstrate the performance of the RDT and any special features that may interest the operations and maintenance staff at the plant. A preliminary daily schedule of activities is provided below and is subject to change.
<table>
<thead>
<tr>
<th>Day</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Deliver and install RDT</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Trial No. 1 using the Water Authority selected polymer with UWAS feed rates of 50 gpm (4 hour run time) and 75 gpm (4 hour run time)</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Trial No. 1 using the Water Authority selected polymer with UWAS feed rate of 100 gpm (4 hour run time)</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Trial No. 2 using the Offeror selected polymer with UWAS feed rate of 50 gpm (4 hour run time)</td>
</tr>
<tr>
<td>Thursday</td>
<td>Trial No. 2 using the Offeror selected polymer with UWAS feed rates of 75 gpm (4 hour run time) and 100 gpm (4 hour run time)</td>
</tr>
<tr>
<td>Friday</td>
<td>Remove the RDT and demobilize</td>
</tr>
</tbody>
</table>

7.1.1.8  Have the responsibility for environmental controls to prevent freezing (RDT units will be located outside and subject to freezing temperatures). It is acceptable to locate the RDT and related equipment in an enclosed trailer provided the enclosure does not inhibit the functionality of the equipment or the Water Authority's ability to observe and document the equipment performance.

7.1.1.9  Have the responsibility of draining the lines at the end of testing each day to prevent freezing. A drain will be made available.

7.1.1.10 Have the option to waive one sample of their choice per day of active demonstration testing. Clearly communicate the intent to waive the sample to the Water Authority's Engineer who will make record of the Offeror's decision.

7.1.1.11 Acknowledge that a representative of the Water Authority's Engineer will be on-site during the pilot operations to collect data and oversee the Offeror's operations.

7.1.1.12 Acknowledge that a split sample of the following flow streams shall be obtained for each hour of operation during the performance test: One half of the sample will be taken by the Water Authority's Engineer for third party lab testing for total suspended solids (TSS). The other half of the sample will be available for the Offeror's testing, if desired.

7.1.1.12.1 Feed sludge.

7.1.1.12.2 Filtrate.

7.1.1.12.3 Thickened sludge.

7.1.2  Acknowledge that the following process data will be recorded and documented each half hour of each 4-hour test by the Engineer:

7.1.2.1 UWAS feed sludge flow rate, solids concentration, and mass rate.
7.1.2.2 Polymer dosage, feed rate, and dosing location.
7.1.2.3 Cumulative thickened sludge flow.
7.1.2.4 Alarm conditions.
7.1.2.5 Equipment problems.
7.1.2.6 Drum drive speed.
7.1.2.7 Floc drive speed.

7.1.3 Utilize the following Water Authority provided utility connections for the pilot demonstration (See Figure 2, Appendix C):

7.1.3.1 UWAS at supply pressure of 5 psig. Offeror to provide feed sludge booster pump as needed and 4-inch flexible pipe from location shown in Figure 2, Appendix C, to Offeror's sludge booster pump.

7.1.3.2 Reuse water at supply pressure average of 80-90 psig, maximum 95 psig. Offeror to provide 1 1/2-inch hose from location shown in Figure 2, Appendix C, to Offeror's RDT and a reuse water booster pump if necessary.

7.1.3.3 Offeror to provide a thickened sludge pump of sufficient capacity and 2-inch discharge pipe to pump thickened sludge from the Offeror's RDT to the discharge location shown on Figure 2, Appendix C.

7.1.3.4 Power panel provided by a Water Authority provided generator at 480 V, 3 phase, 60 Hz, 20 amp within 75 feet. Offeror to provide all electrical conductors between the power panel and the RDT equipment.

7.1.4 Demonstrate Offerors' performance warranties during the pilot testing phase. Offeror claims of performance not demonstrated during the pilot will be considered as prima facie evidence that the Offeror is unable to meet the performance requirements of this project.

7.1.5 Acknowledge that each item proposed will be reviewed using evaluation criteria and the established weighted rating system. A rating score between 1 and 5, with 5 being the best, will be assigned for the evaluation criteria for each proposed item. Scores will be totaled and the Offeror with the highest score will be recommended. The Evaluation Committee will be evaluating the proposals based on the criteria listed below.
<table>
<thead>
<tr>
<th>Category</th>
<th>Criterion</th>
<th>Weighted Value</th>
<th>Maximum Possible score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Quality of Proposal</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Level of completeness and accuracy of proposal</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>Experience and Qualifications</td>
<td></td>
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<tr>
<td></td>
<td>Level of conformance with United States experience requirements</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Level of conformance with United States installations and references requirements for same size RDTs</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Level of conformance with United States installations and references requirements for same model RDTs</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Level of conformance with New Mexico installations and references requirements</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3.</td>
<td>Favorability of References</td>
<td></td>
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<tr>
<td></td>
<td>Actual performance in comparison to specified or guaranteed values</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Quality and timeliness of service</td>
<td>3</td>
<td>15</td>
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<tr>
<td></td>
<td>Required maintenance and ease of maintenance</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Ease of operation and controls</td>
<td>3</td>
<td>15</td>
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<tr>
<td>4.</td>
<td>Warranty</td>
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<tr>
<td></td>
<td>Length and coverage of warranty</td>
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<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>Service Capability</td>
<td></td>
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<tr>
<td></td>
<td>Proximity of currently operating service centers and service center</td>
<td>2</td>
<td>10</td>
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<tr>
<td></td>
<td>capabilities near Water Authority</td>
<td></td>
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<tr>
<td></td>
<td>Level of conformance with service requirements for service calls and spare part delivery</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>6.</td>
<td>Pilot demonstration operation</td>
<td></td>
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<tr>
<td></td>
<td>Ease of operation and controls</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>7.</td>
<td>Pilot demonstration performance</td>
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<tr>
<td></td>
<td>Percent capture of solids: &gt;95 percent</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Percent thickened waste activated sludge (TWAS) solids content: &gt;5.5 percent</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Quantity of polymer per dry pound of solids produced</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>8.</td>
<td>Lifecycle Cost</td>
<td></td>
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<tr>
<td></td>
<td>20 year lifecycle cost of RDT system (capital cost and best performing polymer cost) Calculation completed by the Water Authority</td>
<td>8</td>
<td>40</td>
</tr>
</tbody>
</table>

\[
\text{Lifecycle cost} = \text{Net Present Worth of } \left( \frac{\text{Equipment cost}}{\text{cost}} \right) \\
+ \left( \frac{\text{Polymer cost}}{\text{cost}} \right) (P)(4) \left( \frac{\text{minutes}}{\text{year}} \right) (20)
\]

where 

\[
(P)(4) \text{ is Polymer usage for 100 gpm scaled up for a 400 gpm unit} \\
\left( \frac{\text{minutes}}{\text{year}} \right) \text{ is a unit conversion}
\]
8.0 PROPOSAL FORMAT AND REQUIRED INFORMATION

8.1 Proposals shall provide a straightforward, concise description of the Offeror's capabilities to satisfy the requirements of the RFI. Emphasis should be on completeness, clarity of content, and conveyance of the information requested by the Water Authority.

8.2 The proposal shall be bound in a single volume where practical. All documentation submitted with the proposal should be bound in that single volume.

8.3 If the proposal includes any comment over and above the specific information requested in the RFI, it shall be included as a separate appendix to the proposal.

8.4 The cost submitted shall be valid for 60 days. The cost that will be assigned as an allowance in the General Contractor's bid or offer will be the cost submitted with the cost proposal adjusted based on the difference in the stainless steel cost index as reported in Engineering News Record (ENR). The cost submitted with the cost proposal will be multiplied by the ratio of the ENR stainless steel cost index for March 2018 to the ENR stainless steel cost index for March 2017.

8.5 The proposal shall be organized into the following response item sections and submitted in an indexed binder.

8.5.1 Cover Letter. Cover letter that states the Offeror's understanding of the specifications and services to be provided. Include any additional information believed necessary that is not requested elsewhere in the RFI.

8.5.2 Cost Proposal to provide all elements identified in the procurement specifications.

8.5.3 Manufacturer, name, and safety data sheet (SDS) of Offeror's preferred polymer. Provide contact name of local supplier for polymer.

8.5.4 Equipment Data, Standard Drawings, and Supporting Information. Submit the following:

8.5.4.1 Data completely describing proposed equipment including model number, equipment generation, plan and section views, and listings of all components and materials of construction.

8.5.4.2 Standard installation drawings showing dimensions, weights, and locations of all components, individually and as a combined system. Drawings shall include vibration isolators, locations for anchor bolts, and required process connection sizes and types. Weights shall be provided for each system component, combined weight for all components that must be installed as a unit, and the combined weight of the drum and gearbox when the drum is filled with water. Connection information shall include pipe size and connection type for sludge feed, centrate discharge, cake discharge, polymer, and foul air.
8.5.4.3 Values for all required utilities, including wash water flow and pressure, pressure for sludge feed, and pressure for polymer feed.

8.5.4.4 Dimensions of RDT system components, including drum diameter, overall system footprint, discharge diameter, drum volume for cylindrical section only, and nameplate drum speed.

8.5.4.5 Required clearances for disassembly and maintenance, and indication of how rotating assembly (drum and gearbox) is removed from system.

8.5.4.6 Gearbox system data sheets, description, torque capacity, and reduction ratio.

8.5.4.7 Lubrication system data sheets, layout, and requirements.

8.5.4.8 Static and dynamic loads, including indication of load distribution on vibration isolators.

8.5.4.9 Electrical information, including nameplate motor horsepower for all motors included in the RDT system. Maximum total electrical current draw at 480 volts.

8.5.4.10 Standard interconnecting wiring diagrams for system components.

8.5.4.11 Standard process and instrumentation diagram (P&ID).

8.5.4.12 Dimensions of all required control panels.

8.5.4.13 Dimensions of motor controller units (i.e. VFDs, etc.).

8.5.4.14 Complete description of control systems, proposed PLCs, sequence of operation and list of functions monitored, controlled, and alarmed. Include summaries of available operating modes.

8.5.4.15 Any other information that demonstrates compliance with or exceedance of specified requirements.

8.5.5 Operational and Maintenance Considerations. Provide a summary of the system's operating sequence and recommended operator attention. Provide a summary of required maintenance activities, including frequency of maintenance and part replacement and estimated manhours for each activity. Indicate those maintenance activities that are recommended to be performed by the manufacturer or manufacturer's service representatives.

8.5.6 Scope of Supply. Provide list of all items to be included in your scope of supply and all items specifically excluded from your scope of supply but necessary for a fully functioning and operable system.

8.5.7 Maintenance Service Contracts. Provide list of services included in specified service contracts.
8.5.8 **Conflict of Interest.** Disclosure of any obligations posing a potential conflict of interest, including service on Water Authority boards and/or commissions and any current contracts with the Water Authority. This would apply to the Offeror as well as representatives of the Offeror and entities subcontracted by the Offeror.

8.5.9 **Additional Information.** Any product information or data which the proponent wishes to submit and which is not specifically requested in the above categories.

9.0 **HEALTH AND SAFETY**

The Water Authority staff shall be contacted immediately in the event of a spill. The Water Authority's spill protocol shall be followed in the event of a spill. The spill protocol is included in Appendix B. At a minimum all individuals performing pilot testing shall wear the following personal protective equipment while on the Southside Water Reclamation Plant site:

- Hard helmet
- Steel toe boots
- Safety vest
- Safety glasses
NAME OF ROTARY DRUM THICKENER SYSTEM SUPPLIER: 

NAME OF OFFEROR:  

OFFEROR’S COMPANY NAME: 

### VENDOR QUALIFICATION QUESTIONNAIRE

<table>
<thead>
<tr>
<th>Question</th>
<th>No</th>
<th>Yes</th>
<th>Supporting Documentation Provided?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Based on the specified operating conditions and sludge characteristics, will the RDT system in your proposed system meet the minimum performance requirements specified herein for:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1a. Solids Capacity: 1,250 dry lbs/hr at 0.8 percent total suspended solids (dry weight basis) per RDT.</td>
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<tr>
<td>1b. Percent capture of solids: &gt;95 percent</td>
<td></td>
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</tr>
<tr>
<td>1c. Hydraulic loading: 400 gpm per RDT.</td>
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</tr>
<tr>
<td>1d. Percent thickened waste activated sludge (TWAS) solids content: &gt;5.5 percent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Greater than 5 Installations in the United States servicing municipal applications and thickening similar composition sludge (Provide references for 5 separate installations). Different designs by the same manufacturer are not acceptable as installations.</td>
<td></td>
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<tr>
<td>3. Minimum time similar machine in operation: 5 years</td>
<td></td>
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<tr>
<td>4a. Identify one currently operating service center located closest to the Water Authority.</td>
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<td></td>
</tr>
<tr>
<td>4b. Identify at least one service technician closest to Water Authority, who has been trained specifically on the RDT system required for this project, and who will be available for a field service call within 48 hours of written notice.</td>
<td></td>
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<td>4c. Capable of delivering spare parts, excluding drums, within 48 hours after written notice.</td>
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<tr>
<td>5. Provide a 5-year maintenance agreement to include regular service interval maintenance and replacement of all wear parts at the end of the 5-year period.</td>
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<td>6. Loaner RDT or thickening equipment during major maintenance events.</td>
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DOCUMENTS FOR THE CONSTRUCTION OF

ROTARY DRUM THICKENER

PRE-PROCUREMENT DOCUMENTS

December 2016

OWNER:

Albuquerque Bernalillo County
Water Utility Authority

ENGINEER:

carollo

CONTACT:

PHIL PARKINS (602) 474-4047
ALBUQUERQUE BERNALILLO COUNTY WATER UTILITY AUTHORITY

ROTARY DRUM THICKENER

PRE-PROCUREMENT TECHNICAL SPECIFICATIONS

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SECTION 01410
REGULATORY REQUIREMENTS

PART 1  GENERAL

1.01  SUMMARY
A. Section includes: Regulatory authorities and codes.

1.02  AUTHORITIES HAVING JURISDICTION
A. Building Department: Bernalillo County.
B. Fire Department: Bernalillo County.

1.03  APPLICABLE CODES
A. International Code Council (ICC).
   1. Building code:
   2. Electrical code:
   3. Energy code:
   4. Fire code:
   5. Fuel gas code:
   6. Mechanical code:
   7. Plumbing code:

PART 2  PRODUCTS
Not Used.

PART 3  EXECUTION
Not Used.

END OF SECTION
SECTION 01600

PRODUCT REQUIREMENTS

PART 1  GENERAL

1.01  SUMMARY

A. Section includes: Product requirements; product selection; product options and substitutions; quality assurance; delivery, handling, and storage; and manufacturer’s instructions.

B. Related section:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01756 - Commissioning.
      b. Section 01782 - Operation and Maintenance Data.

1.02  DEFINITIONS

A. Execution: Inclusive of performance, workmanship, installation, erection, application, field fabrication, field quality control, and protection of installed products.

B. Products: Inclusive of material, equipment, systems, shop fabrications, mixing, source quality control.

1.03  REFERENCES

A. American National Standards Institute (ANSI).

B. NSF International (NSF).

1.04  PRODUCT REQUIREMENTS

A. Comply with Specifications and referenced standards as minimum requirements.

B. Provide products by same manufacturer when products are of similar nature, unless otherwise specified.

C. Provide identical products when products are required in quantity.

D. Provide products with interchangeable parts whenever possible.
E. Require each equipment manufacturer to have maintenance facilities meeting the following requirements:
   1. Minimum 3 years operational experience.
   2. Location in continental United States.
   3. Equipment and tools capable of making repairs.
   4. Staff qualified to make repairs.
   5. Inventory of maintenance spare parts.

1.05 PRODUCT SELECTION

A. When products are specified by standard or specification designations of technical societies, organizations, or associations only, provide products that meet or exceed reference standard and Specifications.

B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide:
   1. Products by one of named manufacturers that meet or exceed Specifications.
   2. Products determined by the Engineer to be equal to the products of named manufacturer.

C. When products are specified with names of manufacturers and model numbers or catalog designations, provide:
   1. Products with model numbers or catalog designations by one of named manufacturers.
   2. Products determined by the Engineer to be equal to the products of the named manufacturer.

D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
   1. Products specified by brand or trade name, model number, or catalog designation.
   2. Products by one of named manufacturers proven in accordance with requirements for or equals to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.
   3. Engineer approved equal.

E. When Products are specified with only one manufacturer followed by "or Equal," provide:
   1. Products meeting or exceeding Specifications by specified manufacturer.
   2. Engineer approved equal.

1.06 QUALITY ASSURANCE

A. Employ entities that meet or exceed specified qualifications to execute the Work.

B. Inspect conditions before executing subsequent portions of the Work. Accept responsibility for correcting unsatisfactory conditions upon executing subsequent portions of the Work.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.
1.07 DELIVERY, HANDLING, STORAGE, AND PROTECTION

A. Prepare products for shipment by:
   1. Applying grease and lubricating oil to bearings and similar items.
   2. Separately packing or otherwise suitably protecting bearings.
   3. Tagging or marking products to agree with delivery schedule or shop drawings.
   4. Including complete packing lists and bills of material with each shipment.
   5. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.
   6. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

B. Mandatory requirements prior to shipment of equipment:
   1. Engineer approved shop drawings.
   2. Engineer approved Manufacturer's Certificate of Source Testing as specified in Section 01756.
   3. Submit draft operations and maintenance manuals, as specified in Section 01782.

C. Transport products by methods that avoid product damage. Deliver products in undamaged condition in manufacturer's unopened containers or packaging.

D. Provide equipment and personnel to handle products by methods to prevent soiling or damage.

E. Upon delivery, promptly inspect shipments.
   1. Verify compliance with Contract Documents, correct quantities, and undamaged condition of products.
   2. Immediately store and protect products and materials until installed in Work.
   3. Acceptance of shipment does not constitute final acceptance of equipment.

F. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment and special equipment to be incorporated into this project.
   1. Storage of equipment shall be in strict accordance with the "instructions for storage" of each equipment supplier and manufacturer including connection of heaters, placing of storage lubricants in equipment, etc.
   2. The Contractor shall furnish a copy of the manufacturer's instructions for storage to the Engineer prior to storage of all equipment and materials.
   3. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project.
   4. Equipment and materials not properly stored will not be included in an application for payment.

G. Store products with seals and legible labels intact.

H. Store moisture sensitive products in weathertight enclosures.

I. Maintain products within temperature and humidity ranges required or recommended by manufacturer.
J. Maintain storage areas at ambient temperatures recommended by manufacturer.

K. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces.

L. Exterior storage of fabricated products:
   1. Place on aboveground supports that allow for drainage.
   2. Cover products subject to deterioration with impervious sheet covering.
   3. Provide ventilation to prevent condensation under covering.

M. Store loose granular materials on solid surfaces in well-drained area. Prevent materials mixing with foreign matter.

N. Provide access for inspection.

O. Maintain equipment per the manufacturer's recommendation and industry standards, including oil changes, rotation, etc. Provide a log of equipment maintenance to the Engineer on a monthly basis.
   1. Rotation log shall include, as a minimum, the equipment identification, date stored, date removed from storage, copy of manufacturer's recommended storage guidelines, date of rotation of equipment, and signature of party performing rotation.

P. Protection after installation:
   1. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. Remove covering when no longer needed.

1.08 MANUFACTURER’S INSTRUCTIONS

A. Deliver, handle, store, install, erect, or apply products in accordance with manufacturer's instructions, Contract Documents, and industry standards.

B. Periodically inspect to assure products are undamaged and maintained under required conditions.

C. Provide operations and maintenance manuals as specified in Section 01782:
   1. Draft versions submitted prior to equipment shipment to project.
   2. Final version submitted and approved no later than 60 days prior to Owner Training.

1.09 SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. Provide spare parts, maintenance products, and special tools as required by Specifications.

B. Box, tag, and clearly mark items.

C. Store spare parts, maintenance products, and special tools in enclosed, weather-proof, and lighted facility during the construction period.
   1. Contractor is responsible for spare parts and special tools until acceptance by Owner.
   2. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.
PART 2 PRODUCTS

2.01 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts and special tools inventory list, see Appendix A:
   1. Equipment tag number.
   2. Equipment manufacturer.
   3. Subassembly component, if appropriate.
   4. Quantity.
   5. Storage location.

B. Large items:
   1. Weight: Greater than 50 pounds.
   2. Size: Greater than 24 inches wide by 18 inches high by 36 inches long.
   3. Stored individually.
   4. Clearly labeled:
      a. Equipment tag number.
      b. Equipment manufacturer.
      c. Subassembly component, if appropriate.

C. Smaller items:
   1. Weight: Less than 50 pounds.
   2. Size: Less than 24 inches wide by 18 inches high by 36 inches long.
   3. Stored in spare parts box.
   4. Clearly labeled:
      a. Equipment tag number.
      b. Equipment manufacturer.
      c. Subassembly component, if appropriate.

D. Spare parts and special tools box:
   1. Wooden box:
      a. Size: 24 inches wide by 18 inches high by 36 inches long.
   2. Hinged wooden cover.
      a. Strap type hinges.
      b. Locking hasp.
      c. Spare parts inventory list taped to underside of cover.
   3. Coating: As specified in Section 09960.
   4. Clearly labeled:
      a. The words "Spare Parts and/or Special Tools".
      b. Equipment tag number.
      c. Equipment manufacturer.

PART 3 EXECUTION

3.01 COMMISSIONING

A. As specified in Section 01756.
3.02 CLOSEOUT ACTIVITIES

A. Owner may request advanced delivery of spare parts and special tools.
   1. Deduct the delivered items from inventory and provide transmittal documentation.

B. Immediately prior to the date of Substantial Completion, arrange to deliver spare parts and special tools to Owner at a location on site chosen by the Owner.
   1. Provide itemized list of spare parts and special tools that matches the identification tag attached to each item.
   2. Owner and Engineer will review the inventory and the itemized list to confirm it is complete and in good condition prior to signing for acceptance.

3.03 ATTACHMENTS

A. Appendix A - Spare Parts and Special Tools Inventory List.

END OF SECTION
APPENDIX A
SPARE PARTS AND SPECIAL TOOLS INVENTORY LIST

Owner: ___________________________ Date: ___________________
Contractor: _______________________ Project No.: ______________
Project Name: ______________________

<table>
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<th>Inventory List</th>
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<tr>
<td>Spec Number:</td>
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</table>

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Subassembly Component</th>
<th>Description</th>
<th>Manufacturer's Part Number</th>
<th>Storage Location</th>
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December 2016  01600-7  10128S00
pw://Carollo/Documents/Client/NM/ABCWUA/10128S00/Specifications/01600 (PreProFS)
SECTION 01610
PROJECT DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Project design criteria such as temperature and site elevation.

1.02 PROJECT DESIGN CRITERIA

A. All equipment and materials for the project are to be suitable for performance in wastewater treatment plant environment and under the following conditions:
   1. Design temperatures are:
      a. Outdoor temperatures: -10 to +30 degrees Celsius.
      b. Indoor temperatures for the following buildings:
         1) Electrical rooms: 20 to 30 degrees Celsius.
   2. Design groundwater elevation: 4917 feet above mean sea level.
   3. Moisture conditions: Defined in individual equipment sections.
   4. Site elevation: Approximately 4927 feet above mean sea level.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION
SECTION 01612
SEISMIC DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY
A. Section includes: Seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment.
   2. Seismic design and design of anchorage for small tanks fabricated off site and shipped to the Project site.
   3. Other structures or items as specified or indicated on the Drawings.

1.02 REFERENCES
A. American Society of Civil Engineers (ASCE):

1.03 SYSTEM DESCRIPTION
A. Design in accordance with the requirements of the building code as specified in Section 01410.
B. Design spectral acceleration at short period, $S_{DS}$: .515.
C. Design of non-structural components and their connections to structures:
   1. Component amplification factor, $a_p$: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1 unless otherwise specified.
D. Seismic Design Category (SDC).
E. Seismic Design Category (SDC) for certification of mechanical and electrical equipment as required by ASCE 7:
   1. Wastewater Treatment Facility.
      All areas: Seismic Design Category D.
F. Design requirements: Anchorage of equipment to structures.
   1. Do not use friction to resist sliding due to seismic forces. Do not design or provide connections that use friction to resist seismic loads. Resist seismic forces through direct tension and/or shear on anchors and fasteners.
   2. Do not use more than 60 percent of the weight of the mechanical and electrical equipment for designing anchors for resisting overturning due to seismic forces.
   3. Do not use more than 60 percent of the weight of the tank for resisting overturning due to seismic forces.
   4. Anchoring and fastening to concrete and masonry.
      a. Provide anchors specified in Section 05190.
      b. Do not use concrete anchors, flush shells, sleeve anchors, screw anchors, powder actuated fasteners, or other types of post-installed mechanical anchors unless indicated on the Drawings or accepted in writing by the Engineer.
1.04 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and seismic calculations.

B. Calculations shall be signed and stamped by a civil or structural engineer licensed in the state where the Project is located.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION
SECTION 01756
COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for each Commissioning phase of, the Project equipment/system and/or facility.

B. Related sections:
   1. Section 01782 - Operation and Maintenance Data.
   2. Section 09960 - High-Performance Coatings.
   3. Section 15050 - Common Work Results for Mechanical Equipment.
   7. Section 17950 - Testing, Calibration, and Commissioning.

1.02 DEFINITIONS

A. Commissioning – The process of planning, testing, and process start-up of the installation for compliance with contract requirements and demonstrating, through documented verification, that the project has successfully met the Contractual requirements. It includes training the Owner’s staff to operate the facility.

B. Commissioning Phases – The work activities of facility commissioning are grouped into the phases defined in the table below.

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<th>Process Start-Up Phase</th>
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<td>Owner Training</td>
<td>Process Operational Period</td>
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<td>Installation Testing</td>
<td>Instrumentation and Controls Fine-Tuning</td>
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C. Component – A basic building block of equipment, subsystems, and systems that requires installation or functional testing but does not have an electrical connection or internal electronics. (Examples: effluent piping and manual isolation valves).

D. Device – A basic building block of equipment, subsystems, and systems that requires installation or functional testing and does have an electrical connection or internal electronics. (Examples: tank level transmitter or pump pressure transmitter).

E. Equipment – An assembly of component(s) and devices(s) that requires installation or functional testing. (Examples: Pump, motor, Conveyor, VFD, etc.).
F. Facility – A grouping of process areas, systems, subsystems, equipment, components, and devices (Examples: treatment plant, pump station, etc.).

G. Functional Testing – Testing performed on a completed subsystem to demonstrate that equipment/system meets manufacturers' calibration and adjustment requirements and other requirements as specified. Functional testing includes operating equipment/system manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).

H. Installation Testing – Testing to demonstrate that subsystem component (piping, power, networks, devices, etc.) is ready and meets the project requirements in advance of functional testing. Installation testing also includes manufacturers’ certification of installation and other requirements as specified to prepare equipment/system for Functional Testing. Also referred to as Field Acceptance Testing.

I. Instrumentation and Controls Fine-Tuning – Improving the performance of the Instrumentation Process Control system by operating for an extended time period.

J. Manufacturer's Certificate of Source Testing – When applicable, the form is used during Source Testing for the manufacturer to confirm that the applicable source tests have been performed and results conform to the Contract Documents. The form is provided at the end of this Section.

K. Manufacturer's Certificate of Installation and Functionality Compliance – The form is used during Installation Testing and Functional Testing. It is submitted at the end of Functional Testing to confirm that the equipment/system is installed in conformance with the Contract Documents and that it meets the Functional Testing requirements defined in the Contract Documents. The form is provided at the end of this Section.

L. Process Area – A grouping of systems, subsystems, equipment, components, and devices that divide a facility into functional areas. (Example: Chemical Feed Area).

M. Process Operational Period – A period of time after completion of the process start-up set aside for final Operational Testing to verify facility performance meets the Contract Document requirements. This period may specifically limit other construction activities.

N. Process Start-up Phase – Operating the facility to verify performance meets the Contract Document requirements.

O. Process Start-Up – Activities conducted after the testing and training phase that are necessary to place systems or process areas into operational service.

P. Product – A system, subsystem, or component.

Q. Subsystem – A building block of systems made up from a grouping of components, devices, and equipment that perform a definable function.

R. System – A grouping of subsystems, equipment, components, and devices that perform a definable function.
1.03 SERVICES OF MANUFACTURER’S REPRESENTATIVES

A. Qualification of manufacturer's representative as specified in the Contract Documents technical Sections include the following:
   1. Authorized representative of the manufacturer, factory trained and experienced in the technical applications, installation, operation, and maintenance of respective equipment/system with full authority by the equipment/system manufacturer to issue the certifications required of the manufacturer.
   2. Competent, experienced technical representatives of equipment/system manufacturer for assembly, installation, testing guidance, and training.
   3. Additional qualifications may be specified in the individual Sections.
   4. Submit qualifications of the manufacturer's representative no later than 30 days in advance of required observations.
   5. Representative subject to approval by Owner and Engineer.
   6. No substitute representatives will be allowed until written approval by Owner and Engineer has been obtained.

B. Completion of manufacturer on-site services: Engineer approval required.

C. Manufacturer is responsible for determining the time required to perform the specified services.
   1. Minimum times specified in the Contract Documents are estimates.
   2. No additional costs associated with performing the required services will be approved.
   3. Manufacturer required to schedule services in accordance with the Contractor's project schedule up to and including making multiple trips to project site when there are separate milestones associated with installation of each occurrence of manufacturer's equipment.

D. Manufacturer's on-site services as specified in the Contract Documents include the following:
   2. Provide copies of manufacturer's representatives field notes and data to Engineer.
   3. Other requirements as specified in the Contract Documents.

1.04 PLANNING PHASE

A. Overview of Planning Phase:
   1. Define approach and timing for Commissioning.

B. Owner training plan and schedule:
   1. Training outcomes:
      a. Owner's operations, maintenance, and engineering staff have the information needed to safely operate, maintain, and repair the equipment/systems provided under this Contract.
   2. Training objectives:
      a. To instruct personnel in the operation and maintenance of the equipment/system. Instruction shall include step-by-step troubleshooting procedures with all necessary test equipment/system.
      b. To instruct personnel in the removal, inspection, and cleaning of equipment/system as needed.
c. Training tailored to the skills and job classifications of the staff attending the classes (e.g., plant superintendent, treatment plant operator, maintenance technician, electrician, etc.).

d. Provide supporting documentation, such as vendor operation and maintenance manuals.

3. Training schedule:
   a. Schedule Owner's staff training within the constraints of their workloads. Those who will participate in this training have existing full-time work assignments, and training is an additional assigned work task, therefore, scheduling is imperative. Owner staff work schedules regularly shift, as treatment facilities are typically operated on an around-the-clock basis.

4. Training plan:
   a. Coordinate and arrange for manufacturer's representatives to provide both classroom-based learning and field (hands-on) training, based on training module content and stated learning objectives.
   b. Conduct classroom training at location designated by Owner.
   c. Scope and sequence:
      1) Plan and schedule training in the correct sequence to provide prerequisite knowledge and skills to trainees.
         a) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.

5. Training scheduling coordination:
   a. Contractor is responsible for the following:
      1) Coordinate schedule for training periods with the Owner's personnel and manufacturer's representatives (instructors).
   b. Complete Owner training no sooner than 15 calendar days prior to start of process start-up of each system.

6. Meetings:
   a. Contractor is responsible for setting commissioning coordination meeting dates and times, as well as preparing the agendas and meeting minutes.
   b. Contractor shall meet with Engineer and Owner's designated training coordinator to develop list of personnel to be trained and to establish expected training outcomes and objectives at least 60 calendar days prior to commissioning of equipment/system.
   c. Contractor shall conduct commissioning progress meetings throughout construction, to plan, scope, coordinate, and schedule future activities, resolve problems, etc.
      1) Frequency: Monthly minimum. Increase frequency as determined by the Engineer based on complexity and quantity of commissioning activities.

7. Submittals:
   a. Submit Training Plan Schedule 60 calendar days before the first scheduled training session, including but not limited to lesson plans, participant materials, instructor's resumes, and training delivery schedules.
   b. Submit training documentation including the following:
      1) Training plan:
         a) Training modules.
         b) Scope and sequence statement.
         c) Contact information for manufacturer's instructors including name, phone, and e-mail address.
         d) Instructor qualifications.
2) Training program schedule:
   a) Format: Bar chart.
   (1) Additionally include in the Project Progress Schedule.
   b) Contents:
      (1) Training modules and classes.

8. Training sessions:
   a. Provide training sessions for equipment/system as specified in the individual equipment/system Section.

C. Commissioning Schedule:
   1. Commissioning overview:
      a. Comply with Commissioning Roles and Responsibilities Matrix specified at the end of this Section.
   2. Submittal due date:
      a. Submit Commissioning Schedule not less than 60 calendar days prior to planned initial commissioning of each subsystem or system.
   3. Schedule requirements:
      a. Schedule durations and float for commissioning activities to ensure Work does not fall behind schedule due to complications or delays during commissioning.
      b. Time-scaled network diagram detailing the work to take place in the period between 180 calendar days prior to planned initial commissioning of equipment and systems, and prior to the date of Substantial Completion, together with supporting narrative.
      c. Provide detailed schedule of commissioning activities including durations and sequencing requirements.
         1) Identify the following activities:
            a) Testing and Training Phase:
               (1) Source Testing.
               (2) Owner Training.
               (3) Installation Testing.
               (4) Functional Testing.
               (5) Closeout Documentation.
            b) Process Start-Up Phase:
               (1) Process Start-Up.
               (2) Process Operational Period.
               (3) Instrumentation and Controls Fine-Tuning.
            d. Schedule manufacturer's services to avoid conflict with other on-site testing or other manufacturers' on-site services.
            e. Verify that conditions necessary to allow successful testing have been met before scheduling services.

D. Subsystem testing plans:
   1. Provide separate testing plans for each individual subsystem and system that include the following:
      a. Approach to testing including procedures, schedule, and recirculation requirements.
      b. Test objective: Demonstrate subsystem meets the design requirements as specified in the technical Sections.
      c. Test descriptions, forms, temporary systems (pumps, piping, etc.), shutdown requirements for existing systems, test forms, test logs, witness forms, and checklists to be used to control and document the required tests.
d. Test forms: Include, but not limited to, the following information:
   1) Tag and name of equipment/system to be tested.
   2) Test date.
   3) Names of persons conducting the test.
   4) Names of persons witnessing the test, where applicable.
   5) Test data.
   6) Applicable project requirements.
   7) Check offs for each completed test or test step.
   8) Place for signature of person conducting tests and for the witnessing person, as applicable.

e. Define start-up sequencing of unit processes:
   1) Include testing of alarms, interlocks, permissives, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
   2) Provide detailed test procedures setting forth step-by-step descriptions of the procedures for systematic testing of equipment/system.
   3) Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration.
      a) Perform initial checks in the presence of and with the assistance of the manufacturer’s representative.
   4) Demonstrate proper operation of each control loop function including mechanical, electrical, alarms, local and remote controls, instrumentation, and other equipment/system functions.
      a) Generate signals with test equipment/system to simulate operating conditions in each control mode.

2. Engineer approval of test plan is required prior to performing test.
   a. Revise and update test plans based on review comments, actual progress, or to accommodate changes in the sequence of activities.
   b. Submit test reports for each phase of testing for each equipment/system.
   c. Engineer approval of preceding test reports is required prior to start of next test.
   d. Tests will be rescheduled if test plan is not approved by the required deadline.
      1) Contractor is responsible for any resulting delay.

3. Contractor is responsible to reproduce and distribute final test procedures.
   a. Provide 3 copies for Engineer.

4. Tests may commence only after Engineer has received approved test plan copies.

5. Submittals:
   a. Submit test plans not less than 30 calendar days prior to planned installation testing of subsystem or system.
   b. Completed Manufacturer’s Certificate of Installation and Functionality Compliance.
   c. Test procedures and forms: Provide signed-off copy of test forms and test reports upon completion of the test.
   d. Test reports:
      1) Submit preliminary copies within 1 day after testing completion.
      2) Submit final copies and report within 14 days after testing completion.
1.05 TESTING AND TRAINING PHASE

A. Overview of Testing And Training Phase:
   1. General:
      a. Include specified Source Testing, Owner Training, Installation Testing, Functional Testing, and Closeout Documentation required by this Section and the technical Sections.
   2. Contractor responsibilities:
      a. Furnish labor, all chemicals including liquid polymer through substantial completion, tools, equipment, instruments, and services required for and incidental to completing commissioning activities in accordance with the approved Commissioning Plans.
      b. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.
      c. Acceptable tests: Demonstrate the equipment/system performance meets the requirements stated in the Contract Documents.
         1) When the equipment/system fails to meet the specified requirements, perform additional, more detailed, testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.

B. Source Testing:
   1. Also referred to as factory testing or factory acceptance testing (FAT).
   2. Test components, devices, and equipment/system for proper performance at point of manufacture or assembly as specified in the technical Sections.
   3. Notify the Engineer in writing when the equipment/system is ready for source inspection and testing.
   4. Source Test Plan:
      a. As specified in this Section and other technical Sections.
      b. Source Testing requirements as specified in technical Sections.
         1) Non-witnessed: Provide Manufacturer's Certificate of Source Testing.
         2) Witnessed: 1 Owner's representative and 1 Engineer's representative present during testing, unless otherwise specified, and provide Manufacturer's Certificate of Source Testing.
      c. Prepared by Contractor as a result of discussions and planning emerging from regularly conducted commissioning meetings for source tests as specified in the Contract Documents.
      d. Provide the following items for each Source Test:
         1) Purpose and goals of the test.
         2) Identification of each item of equipment/system, including system designation, location, tag number, control loop identifier, etc.
         3) Description of the pass/fail criteria that will be used.
         4) Listing of pertinent reference documents (Contract Documents and industry standards or Sections applicable to the testing).
         5) Complete description, including drawings or photographs, of test stands and/or test apparatus.
         6) Credentials of test personnel.
         7) Descriptions of test equipment to be used, product information, and all appropriate calibration records for the test equipment.
         8) Test set-up procedures.
   a) The level of detail shall be sufficient for any witness with a rudimentary technical aptitude to be able to follow the steps and develop confidence that the tests were being performed as planned.
   b) All steps are significant, and all steps shall be included in the procedures.
10) Sample data logs and data recording forms.
11) Sample computations or analyses with the results in the same format as the final report to demonstrate how data collected will be used to generate final results.
   a) Complete disclosure of the calculation methodologies.
   b) Include a sample for each type of computation required for the test and analysis of the results.
12) Detailed outline of the Source Test report.
13) Sample test reports.
e. Submit Source Test Plan and forms as specified in the technical Sections.
   1) Submit a copy of the Source Test Plan at least 21 days before any scheduled test date.
   2) Engineer approval of Source Test Plan required prior to beginning source testing.
   3) Schedule the testing after approval of the test procedures submittal.
f. Indicate the desired dates for source inspection and testing.
   1) Notify the Engineer of the scheduled tests a minimum of 15 days before the date of the test.

5. Test results:
   a. Prepare and submit test results with collected data attached.
6. Contractor is responsible for costs associated with Owner’s representatives and Engineer’s representative witnessing Source Tests.
   a. Include costs for at least the following:
      1) On-site time: 1 day at the site plus travel time each direction, unless specified otherwise.
      2) Transportation costs:
         a) Travel 1 day on commercial airline to site including air flight costs.
         b) Travel 1 day on commercial airline from site including air flight costs.
         c) Mid-size rental car or taxi services from hotel to and from the test site plus fuel, tolls, and airport parking at the departing airport.
         d) International travel: Per diem rates as established by the US Department of State for the specific location and dates of travel. Travel expenses may include the direct cost of securing passports, visas, language interpreters, document translators, communications, and internet access.
      3) Hotel costs at a facility with an American Automobile Association 3 diamond rating or better for single occupancy room per person per day.
      4) Meal allowance of $61 per person per day.
      5) On-site time: 1 day at the site, unless specified otherwise.
      6) Only actual costs will be documented and billed.
b. If Source Test is not ready when the witnesses arrive or if the Source Test fails, the witnesses will return home with Contractor responsible for costs associated with the trip including costs described above. Contractor is responsible for rescheduling the Source Test and witnesses' costs associated with the second trip including costs described above.

c. Fees incurred such as airline reservation change fees, loss of fare due to purchase of nonrefundable tickets, hotel cancellation/rebooking fees, and similar expenses incurred as a result of OSS-requested changes to the inspection schedule after the initial notification shall be borne by the Contractor.

d. Contractor is responsible for witnesses’ costs associated with retests including costs described above.

7. Contractor is responsible for providing fuel, chemicals, and other consumables needed for Source Testing.

C. Owner training:

1. Training instruction format:
   a. The training for operations personnel shall be provided separately from the maintenance personnel.
      1) The training for maintenance personnel shall be further subdivided into 3 trade groups:
         a) Mechanical maintenance.
         b) Electrical maintenance.
         c) Instrumentation and controls maintenance.
   b. Instructors shall apply adult education best practices, emphasizing learner participation and activity.
   c. Training delivery may include problem solving, question/answer, hands-on instruction, practice, evaluation/feedback tools, and lecture.
   d. Visual aids and hands-on practice sessions must support training objectives.
   e. Lecturing should be less than 30 percent of class time.
   f. Conduct hands-on instruction according to the following descriptions:
      1) Present hands-on demonstrations of at least the following tasks:
         a) Proper start-up, shutdown, and normal and alternative operating strategies.
         b) Common corrective maintenance repairs for each group.
         c) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.
      2) Use tools and equipment provided by manufacturer to conduct the demonstrations.
         a) Submit requests for supplemental assistance and facilities with the Contractor’s proposed lesson plans.
      3) Contractor remains responsible for equipment disassembly or assembly during hands-on training situations involving equipment disassembly or assembly by Owner’s personnel.
         a) Provide written certification of proper equipment/system operation to Engineer after completion of hands-on training.

2. Class agenda:
   a. Include the following information in the agenda:
      1) Instructor name.
      2) Listing of subjects to be discussed.
      3) Time estimated for each subject.
4) Allocation of time for Owner staff to ask questions and discuss the subject matter.

5) List of documentation to be used or provided to support training.

b. Owner may request that particular subjects be emphasized and the agenda be adjusted to accommodate these requests.

c. Distribute copies of the agenda to each student at the beginning of each training class.

3. Number of students:

a. Estimated maximum class size: 10 persons.
   1) Owner will determine the actual number of students.
   2) Engineer will provide an estimated headcount 1 week prior to the class, so that the instructor can provide the correct number of training aids for students.

4. Instructor qualifications:

a. Provide instructors completely knowledgeable in the equipment/system for which they are training.

b. Provide instructors experienced in conducting classes.

c. Provide instructor's technical preparation and instructional technology skills and experience.

d. Sales representatives are not qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.

e. If, as determined by the Owner, an appropriately knowledgeable person did not provide the scheduled training, such training shall be rescheduled and repeated with a suitable instructor.

5. Training aids:

a. Instructors are encouraged to use audio-visual devices, P&IDs, models, charts, and so forth to increase the transfer of knowledge.

b. Instructors shall provide such equipment (televisions, video recorder/player, computer, projectors, screens, easels, etc.), models, charts, and so forth for each class.

6. Classroom documentation:

a. Trainees will keep training materials and documentation after the session.

b. Operations and maintenance manuals, as specified in technical Sections:
   1) Provide a minimum of 2 copies of final Engineer-approved operations and maintenance manuals as specified in Section 01782 for use during the classroom instruction.
   2) Owner reserves the right to delay training for a particular equipment item if the operations and maintenance manuals for that equipment are incomplete, inaccurate, or otherwise unsuitable for use by the Owner's staff.
   3) No contract extensions or extra costs will be allowed for training delays due to operations and maintenance manual submittal delays.

c. Provide supplemental documentation handouts to support instruction.

d. Digitally record audio and video of each training class.
   1) Include classroom and field instruction with question and answering periods.
2) Engineer approval required for producer of video materials from one of the following options:
   a) Qualified, professional video production company.
   b) Contractor demonstrates satisfactory skill.
3) Record in digital format and recording shall become property of the Owner.
   a) Provide audio quality that is not degraded during the recording of the field sessions due to background noise, space, distance or other factors.
4) Video files shall be file format and delivery medium as directed and approved by Owner.
5) Provide 2 complete sets of video materials fully indexed and cataloged with printed labels stating session content and dates recorded.
6) The Contractor shall provide a written release from all claims to the recorded training material produced, if required.

e. Training modules:
   1) Provide a training module for each equipment category.
   2) Divide each training module's instructional content into discrete lesson plans.

f. Lesson plans:
   1) Provide performance-based learning objectives.
   2) State learning objectives in terms of what the trainees will be able to do at the end of the lesson.
   3) Define student conditions of performance and criteria for evaluating instructional success.
      a) Provide the following information.
   4) Instruction lesson plan outlines for each craft.
      a) Provide specific components and procedures.
   5) Minimum requirements:
      a) Hands-on demonstrations planned for the instructions.
      b) Cross-reference training aids.
      c) Planned training strategies such as whiteboard work, instructor questions, and discussion points or other planned classroom or field strategies.
      d) Attach handouts cross-referenced by section or topic in the lesson plan.
      e) Indicate duration of outlined training segments.
   6) Provide maintenance instruction lesson plans including mechanical, instrumentation, and electrical aspects:
      a) Equipment operation:
         (1) Describe equipment's operating (process) function and system theory.
         (2) Describe equipment's fundamental operating principles and dynamics.
         (3) Identify equipment's mechanical, electrical, and electronic components and features.
         (4) Identify support equipment associated with the operation of subject equipment.
         (5) Detail the relationship of each piece of equipment or component to the subsystems, systems, and process.
(6) Cite hazards associated with the operations, exposure to chemicals associated with the component, or the waste stream handled by the component.

(7) Specify appropriate safety precautions, equipment, and procedures to eliminate, reduce, or overcome hazards.

b) Detailed component description:

(1) Define Preventative Maintenance (PM) inspection procedures required on equipment in operation, spot potential trouble symptoms (anticipate breakdowns), and forecast maintenance requirements (predictive maintenance).
   (a) Review preventive maintenance frequency and task analysis table.

(2) Identify each component function and describe in detail.

(3) Where applicable, group relative components into subsystems.

(4) Identify and describe in detail equipment safety features, permissive and controls interlocks.

7) Provide the following information in equipment troubleshooting lesson plans:

a) Define recommended systematic troubleshooting procedures as they relate to specific craft problems.

b) Provide component specific troubleshooting checklists as they relate to specific craft problems.

8) Provide the following information in equipment Corrective Maintenance (CM) troubleshooting lesson:

a) Describe recommended equipment preparation requirements as they relate to specific craft problems.

b) Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.

c) Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.

d) Perform at least 2 hands-on demonstrations of common corrective maintenance repairs.
   (1) Additional demonstrations may be required by the Owner.

e) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

7. Class logistics:
   a. Delivery time minimum: 2 hours.
   b. Delivery time maximum: 4 hours.
      1) Longer time requires Engineer approval.
   c. Class agenda:
      1) Refreshment break: One 10-minute break.
         a) Provide refreshments such as coffee, tea, juice, cold soft drinks, a selection of bakery items, and fresh fruit.
      2) Meal break: One 45-minute break, unless otherwise specified.
      3) Schedule refreshment breaks and meal breaks to meet the class needs and Owner work rules.
d. Schedule specific sessions:
   1) Minimum of 30 days in advance to allow Owner staffing arrangements to take place.
   2) At the times requested by the Owner, within the period 6 a.m. to 6 p.m. Monday through Friday.
      a) Times scheduled will be at Owner's discretion.
   3) Owner approval and confirmation required for session schedules.
   4) Provide minimum of 2 sessions for each class unless otherwise noted.
      a) The purpose of having multiple sessions on each class is to accommodate the attendance of as many Owner personnel working different shifts as possible.
      b) A maximum of 1 session per day for each class.

8. Distribute Training Evaluation Form following each training session.
   a. Training Evaluation Form is included in this Section.
   b. Return completed Training Evaluation Forms to Owner's designated training coordinator immediately after session is completed.
   c. Revise training sessions judged "Unsatisfactory" by a majority of attendees.
      1) Conduct training sessions again until a satisfactory rating is achieved at no additional cost to Owner. The Contractor shall be responsible for all costs associated with repeated training sessions including costs for trainee time.

9. Submittals:
   a. Prior to the training session:
      1) Instructor qualifications: 30 calendar days prior to initial training session.
      2) Training course materials: 14 calendar days prior to initial training session.
         a) Training agenda, lesson plan, presentation, and handouts.
         b) Other audio-visual aids utilized during each training course.
         c) Format: 2 electronic copies and 3 hard copies organized in notebooks.
   b. Post training session:
      1) Training course materials: Due 14 calendar days after class completion.
         a) Video recordings.
         b) Class attendance sheet.
         c) Training agenda, final lesson plan, presentation, and handouts.
         d) Other audio-visual aids utilized during each training course.
         e) Provide materials for all sessions of the class in a single transmittal.
         f) Format: 2 electronic copies and 3 hard copies organized in notebooks.

D. Installation Testing:
   1. Perform subsystem testing according to approved Subsystem Testing Plans.
   2. Initiate the Manufacturer's Certificate of Installation and Functionality Compliance for all equipment.
      a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.
b. Manufacturer’s Certificate of Installation and Functionality Compliance certifies the equipment meets the following requirements:
   1) Has been properly installed, adjusted, aligned, and lubricated.
   2) Is free of any stresses imposed by connecting piping or anchor bolts.
   3) Is able to be operated as necessary for Functional Testing.

c. Form shall be submitted after completion of Functional Testing, as specified in this Section.

3. Coordinate Installation Testing with restrictions and requirements as specified in Section 01140.

4. Perform coating holiday testing as specified in Section 09960.

5. Perform pressure and leakage testing as specified in individual component Sections and Section 15956.

6. Perform mechanical equipment Installation Testing: As specified below and in individual equipment Sections, such as Sections 15050, 15954, and 15958:
   a. Remove rust preventatives and oils applied to protect equipment during construction.
   b. Flush lubrication systems and dispose of flushing oils.
      1) Recharge lubrication system with lubricant recommended by manufacturer.
   c. Flush fuel system and provide fuel for testing and start-up.
   d. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
   e. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
   f. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
   g. Perform cold alignment and hot alignment to manufacturer's tolerances.
   h. Adjust V-belt tension and variable pitch sheaves.
   i. Inspect hand and motorized valves for proper adjustment.
      1) Tighten packing glands to ensure no leakage, but permit valve stems to rotate without galling.
      2) Verify valve seats are positioned for proper flow direction.
   j. Tighten leaking flanges or replace flange gasket.
      1) Inspect screwed joints for leakage.
   k. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

7. Electrical devices and subsystems Installation Testing: As specified in Section 16950, and the technical Sections.

8. Instrumentation devices and subsystems Installation Testing: As specified in Section 17950, and technical Sections.

9. Heating, ventilating, and air conditioning systems Installation Testing: As specified below, in Section 15954, and technical Sections.
   a. Perform testing of heating, ventilating, and air conditioning equipment, balancing of distribution systems, and adjusting of ductwork accessories.
   b. Test hydronic systems, if required by technical Sections.

E. Functional Testing:
   1. Perform subsystem testing according to approved Subsystem Testing Plan.
   2. Notify the Engineer 5 days prior to when the Work is ready for Functional Testing.
      a. Perform testing in the presence of the Engineer.
3. Determine Functional Testing durations with Owner's input.
   a. Durations will vary depending on the availability of water for testing.
   b. Target minimum Functional Test duration: 8 hours.
      1) Identify equipment/system that cannot be tested for a minimum of 8 hours as specified in technical Sections.

4. Perform Functional Testing as specified in technical Sections.
   a. Perform Functional Testing in addition to the other tests specified in the technical Sections.
   b. Perform Functional Testing to demonstrate that the component equipment functions as an entire system in accordance with the design requirements.
   c. Perform Functional Testing to demonstrate that the unit process has operated in a manner necessary to demonstrate equipment/system functions manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).
   d. Perform testing with Owner-provided water.
   e. Repair or replace parts that operate improperly and retest.
   f. Submit testing results as specified in the technical Sections to the Owner and Engineer for approval of Functional Testing results.

5. Provide completed Manufacturer's Certificate of Installation and Functionality Compliance forms for all equipment.
   a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.
   b. Manufacturer's Certificate of Installation and Functionality Compliance certifies the equipment/system meets the following requirements:
      1) Is suitable for satisfactory full-time operation under full-load conditions.
      2) Operates within the allowable limits for vibration and noise.
      3) Electrical and instrumentation requirements:
         a) Electrical equipment, instrumentation, and control panels are properly installed, calibrated, and functioning.
         b) Electrical Installation Testing is complete, and test results have been approved by the Engineer.
            (1) Noted deficiencies have been corrected.
            (2) Relays, circuit breakers, and other protective devices are set.
         c) Control logic for start-up, shutdown, sequencing, interlocks, control, and emergency shutdown has been tested and is properly functioning.
         d) Motor control is calibrated and tested.

F. Closeout documentation:
   1. Submittals:
      a. Provide records generated during Commissioning Phase of Project.
      1) Required documents include but are not limited to:
         a) Training documentation.
         b) Manufacturer's Certificate of Source Testing.
         c) Manufacturer's Certificate of Installation and Functionality Compliance.
         d) Daily logs of equipment/system testing identifying tests conducted and outcome.
         e) Test forms and documentation.
         f) Functional Testing results.
g) Logs of time spent by manufacturer's representatives performing services on the job site.

h) Equipment lubrication records.
i) Electrical phase, voltage, and amperage measurements.
j) Insulation resistance measurements.
k) Bearing temperature measurements.

2) Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints. Format: 2 electronic copies and 3 hard copies organized in notebooks.

3) Due date: Within 14 calendar days of Substantial Completion.

1.06 PROCESS START-UP PHASE

A. Overview of Process Start-Up Phase:
   1. Operating the facility to verify performance meets the Contract Document requirements.

B. Process Start-Up:
   1. Perform process start-up in the presence of the Engineer.
   2. Pre-start-up activities:
      a. Commissioning Documentation and Data Review.
      b. Start-Up Go/No-Go Decision Criteria.
      c. Process Start-Up Sequence Review.
         1) Submit a Process Start-Up plan for review by Engineer not less than 60 calendar days prior to planned commencement of process start-up activities.
         2) Include the following:
            a) Pre-start-up activities.
            b) Process Start-Up.
            c) Process Operational Period.
      d. Final Process Start-Up Forms and Documentations.
      e. Final Operational Testing Plan.
   3. Control loop tuning.
      a. Perform control loop tuning during system testing.
      a. Process start-up individual process areas comprised of multiple interdependent systems where possible and beneficial to reduce complexity and risk of complete facility testing.
      b. Process area test flows may be limited by upstream and downstream process constraints (i.e., tank and basin volumes) and/or localized recirculation capabilities.
   5. Facility-wide process start-up.
      a. Upon approved completion of pre-start-up activities, perform entire facility process start-up.
         1) Complete control loop tuning during this phase of process start-up.
         2) Continue process start-up operations until facility meets or exceeds the Contract requirements.
      b. Process control systems testing.
         1) Test complete system instrumentation, controls and PLC, HMI, and LOI programming for the facility.
      c. HVAC systems start-up and testing.
         1) Test complete HVAC system for the facility.
d. Remaining equipment/system tests:
   1) Conduct remaining specified equipment/system performance tests that could not be performed during the Testing and Training Phase due to inter-system and/or treatment process dependencies.

C. Process Operational Period:
   1. Prior to beginning the Process Operational Period:
      a. Conformance with treatment standards is required prior to Operational Testing, if applicable.
      b. Correct any outstanding punchlist items prior to the Operational Testing.
   2. Duration: 14 calendar days.
   3. Engineer will be present for process operational period unless such presence is expressly waived in writing.
   5. Contractor to provide:
      a. Specified start-up materials and operating supplies.
      b. Necessary craft of labor assistance, in the event of an emergency equipment failure requiring immediate attention (emergency is defined as a failure of function which precludes the further operation of a critical segment of or the whole of the Work) with a response time of not more than 4 hours from the time of notification.
      c. Manufacturer's authorized representative to supervise placing equipment/systems in operation and provide guidance during Operational Testing per applicable Section.
      d. Necessary manufacturer's representatives and operating supplies for retesting systems that fail to pass the initial Operational Testing due to deficiencies in products of workmanship at no additional cost to the Owner.
      e. List of 24-hour "on-call" representative supervisory persons who will monitor the Operational Testing and serve as liaison for the Engineer and Owner.
   6. Owner will provide:
      a. Operations personnel for duration of test.
   7. Prior to date of Substantial Completion of Installation, the Contractor shall oversee Process Operational Period.
      a. Owner staff will operate the completed Project construction.
      b. Entire system shall continuously meet performance requirements and shall operate without fault, failure, or defect for a continuous period.
      c. Individual equipment/system failures that are corrected within 24 hours and do not prevent the entire project from continuously satisfying the established operational requirements shall not require the consecutive day test to be restarted unless the failure recurs.
      d. Restart the consecutive test period for any of the following conditions:
         1) Any failure of the complete Project construction to meet operational requirements.
         2) When malfunctions or deficiencies cause shutdown or partial operation of the facility, or results in failure of the complete Project construction to meet operational requirements.
         3) Any individual equipment/system failure that meets any of the following conditions:
            a) Requires more than 24 hours to correct, unless otherwise specified in Section 17950.
b) Recurs within the 24-hour correction period requiring further correction.
4) Immediately correct defects in material, workmanship, or equipment/system which became evident during Operational Testing.

1.07 INSTRUMENTATION AND CONTROLS FINE-TUNING

A. After the Process Operational Period, test PCIS system for additional 60 days as specified in Section 17950 to identify issues and make corrections, as needed.

PART 2 PRODUCTS
Not Used.

PART 3 EXECUTION
Not Used.

END OF SECTION
MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

<table>
<thead>
<tr>
<th>OWNER</th>
<th>EQPT/SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT NAME</td>
<td>EQPT TAG NO.</td>
</tr>
<tr>
<td>PROJECT NO.</td>
<td>EQPT SERIAL NO.</td>
</tr>
<tr>
<td>SPECIFICATION NO.</td>
<td>SPECIFICATION TITLE</td>
</tr>
</tbody>
</table>

Comments:  

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract Documents, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: ________________, 20__

Manufacturer:

Manufacturer's Authorized Representative Name *(print)*: __________________________

(Authorized Signature)

If applicable, Witness Name *(print)*: __________________________

(Witness Signature)
MANUFACTURER’S CERTIFICATE OF INSTALLATION AND FUNCTIONALITY COMPLIANCE

OWNER ___________________________ EQPT/SYSTEM ___________________________
PROJECT NAME ___________________ EQPT TAG NO. ___________________________
PROJECT NO. _______________________ EQPT SERIAL NO. _______________________ 
SPECIFICATION NO. ________________ SPECIFICATION TITLE ____________________

I hereby certify that the above-referenced equipment/system has been: (Check Applicable)

☐ Installed in accordance with manufacturer’s recommendations.
☐ Inspected, checked, and adjusted.
☐ Serviced with proper initial lubricants.
☐ Electrical/instrumentation and mechanical connections meet quality and safety standards.
☐ All applicable safety equipment has been properly installed.
☐ Functionally tested.
☐ System has been performance tested, and meets or exceeds specified performance requirements.

NOTES:
Attach test results with collected data and test report.

Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: ________________________________________________________________

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

Date: _____________________________, 20___

Manufacturer: _________________________________

Manufacturer’s Authorized Representative Name (print): ______________________________

By Manufacturer’s Authorized Representative: ____________________________

(Authorized Signature)
COMMISSIONING
TRAINING EVALUATION FORM

EQUIPMENT/SYSTEM ITEM: 

VENDOR/MANUFACTURER: 

DATE: _______________ NAME OF REPRESENTATIVE: __________________________

1. Was representative prepared? Acceptable Unacceptable or N/A
2. Was an overview description presented? Acceptable Unacceptable or N/A
3. Were specific details presented for system components? Acceptable Unacceptable or N/A
4. Were alarm and shutdown conditions clearly presented? Acceptable Unacceptable or N/A
5. Were step-by-step procedures for starting, stopping, and troubleshooting presented? Acceptable Unacceptable or N/A
6. Were routine/preventative maintenance items clearly identified? Acceptable Unacceptable or N/A
7. Was the lubrication schedule (if any) discussed? Acceptable Unacceptable or N/A
8. Was the representative able to answer all questions? Acceptable Unacceptable or N/A
9. Did the representative agree to research and answer unanswered questions? Acceptable Unacceptable or N/A
10. Comments: ________________________________________________________________

11. Overall Rating: Satisfactory Unsatisfactory

Note:
Sessions judged "Unsatisfactory" by a majority of attendees shall be revised and conducted again until a satisfactory rating is achieved.
<table>
<thead>
<tr>
<th>NO.</th>
<th>TASK</th>
<th>OWNER</th>
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<th>ENGINEER</th>
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<td>Wide Area Network Communications Testing</td>
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<td>Manufacturer's Certificate of Installation and Functionality Compliance</td>
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<td>Start-Up Go/No-Go Decision Criteria</td>
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<td>Start-Up Forms Finalization</td>
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<td>Operation Testing Plan Finalization</td>
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<td>Test Water Management Plan Finalization</td>
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<td>Process Control Systems Testing</td>
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**Legend:**
- **Lead:** Primarily responsible for organization, coordination, and execution of task work product or result.
- **Support:** Assist the lead with organization, coordination, and execution of task work product or result.
- **Witness:** Observe and document completion of task work product or result.
- **Review:** As necessary to accept task work product result.
- **No Action:** Limited or no involvement.
SECTION 01782
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preparation and submittal of Operation and Maintenance Manuals.

B. Related section:

1.02 SUBMITTALS

A. Submit Operation and Maintenance Manuals before field quality control testing and before training of each piece of equipment or system.

B. Submit 4 Manuals for each piece of equipment or system.

C. Make manuals available at project site for use by construction personnel and Owner.

D. Make additions and revisions to the Manuals in accordance with Owner's review comments.

1.03 OPERATION AND MAINTENANCE MANUALS

A. Preparation:
   2. Provide original and clear text on reproducible non-colored paper.
   3. Provide all dimensions in English units.

B. Contents of Operation and Maintenance Manuals:
   1. Cover page: Equipment name, equipment tag number, project name, Owner's name, appropriate date.
   2. Table of Contents: General description of information provided within each tab section.
   3. Equipment Summary Form: Completed form in the format shown in Appendix A. The manufacturer's standard form will not be acceptable.
   4. Lubrication information: Required lubricants and lubrication schedules.
   5. Control diagrams:
      a. Internal and connection wiring, including logic diagrams, wiring diagrams for control panels, ladder logic for computer based systems, and connections between existing systems and new additions, and adjustments such as calibrations and set points for relays, and control or alarm contact settings.
      b. Complete set of 11-inch by 17-inch drawings of the control system.
      c. Complete set of control schematics.
6. Programming: Copies of all Contractor furnished programming.
7. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.
8. Operating procedures:
   a. Step-by-step procedures for starting, operating, and stopping equipment under specified modes of operation.
   b. Include safety precautions and emergency operating shutdown instructions.
9. Preventative maintenance procedures: Recommended steps and schedules for maintaining equipment.
10. Overhaul instructions: Directions for disassembly, inspection, repair, and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.
11. Parts list:
   a. Complete parts list for all equipment being provided.
      Catalog data for all products or equipment furnished including generic title and identification number of each component part of equipment.
      1) Include bearing manufacturer, model and ball or roller pass frequencies for every bearing.
12. Spare parts list: Recommended number of parts to be stored at the site and special storage precautions.
13. Drawings:
   a. Exploded view or plan and section views with detailed callouts.
   b. Complete set of 11-inch by 17-inch drawings of equipment.
   c. Provide electrical and instrumentation schematic record drawings.
14. Source (factory) quality control test results: Provide copies of factory test reports as specified in Section 15958 or the equipment section.
15. Field quality control test results: After field-testing is completed, insert field test reports as specified in Section 15958 or the equipment section.
16. Equipment Summary Form:
   a. Completed form in the format attached at the end of this Section.
   b. Insert Equipment Summary Form after the tab sheet of each equipment section.
   c. The manufacturer's standard form will not be acceptable.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION
## APPENDIX A
### EQUIPMENT SUMMARY FORM

1. **EQUIPMENT ITEM**

2. **MANUFACTURER**

3. **EQUIPMENT IDENTIFICATION NUMBER(S)**
   (maps equipment number)

4. **LOCATION OF EQUIPMENT**

5. **WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)**

6. **NAMEPLATE DATA -**
   - Horsepower
   - Amperage
   - Voltage
   - Service Factor (S.F.)
   - Speed
   - ENC Type
   - Capacity
   - Other

7. **MANUFACTURER'S LOCAL REPRESENTATIVE**
   - Name
   - Address
   - Telephone Number

8. **MAINTENANCE REQUIREMENTS**

9. **LUBRICANT LIST**

10. **SPARE PARTS (recommendations)**

11. **COMMENTS**
SECTION 05120
STRUCTURAL STEEL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Structural steel shapes and plate.
   2. Fasteners and structural hardware:
      a. All thread rods.
      b. High-strength bolts.
   3. Welding.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as
      binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of
      subcontractors, suppliers, and other individuals or entities performing or
      furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This
      list of Related Sections is provided for convenience only and is not intended to
      excuse or otherwise diminish the duty of the Contractor to see that the
      completed Work complies accurately with the Contract Documents.
      a. Section 05190 - Mechanical Anchoring and Fastening to Concrete and
         Masonry.
      b. Section 09960 - High-Performance Coatings.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. 303 - Code of Standard Practice for Steel Buildings and Bridges.
   2. 360 - Specification for Structural Steel Buildings.

B. American Iron and Steel Institute (AISI):
   1. Steel and stainless steel alloys ("types") as indicated.

C. American Welding Society (AWS):
   1. A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc
      Welding.
      Arc Welding.
   5. D1.6 - Structural Welding Code - Stainless Steel.
D. ASTM International (ASTM):
6. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
11. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

E. Research Council on Structural Connections (RCSC):

1.03 DEFINITIONS

A. Snug-tight: At bolted joints, the tightness attained with a few impacts of an impact wrench, or by the full effort of an ironworker using a spud wrench to bring the connected plies into firm contact.

B. Stainless steel related terms:
1. Descaling: Removal of heavy, tightly adherent oxide films resulting from hot-forming, heat-treatment, welding, and other high-temperature operations.
2. Pickling: Chemical descaling of stainless steel using aqueous solutions of nitric and hydrofluoric acid, or various proprietary formulations as specified.
3. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.
1.04 SUBMITTALS

A. Product data:
   1. Compressible-washer-type direct tension indicators: Manufacturer's detailed installation instructions including:
      a. Requirements for type and frequency of pre-installation verification.
      b. Requirements for coordination with regular washers.
      c. Instructions for assembling and tightening the joint so that work progresses from the most rigid part until the connected plies are in firm contact.
   2. Stainless steel: Fabricator name and qualifications, and specifications and procedures used for pickling and passivating members.

B. Quality control submittals:
   1. Submit shop drawings of members to be fabricated before starting fabrication.
   2. Welder's certificates.

C. Test reports:
   1. Certified copies of mill tests and analyses made in accordance with applicable ASTM standards, or reports from a recognized commercial laboratory, including chemical and tensile properties of each shipment of structural steel or part thereof having common properties.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Perform welding of structural metals with welders who have current AWS certificate for the type of welding to be performed.
   2. Steel fabricators shall be certified by the AISC or other certification as recognized and accepted by the local building official having jurisdiction.
   3. Notify Engineer 24 hour's minimum before starting shop or field welding.
   4. Engineer may check materials, equipment, and qualifications of welders.
   5. Remove welders performing unsatisfactory Work, or require to requalification.
   6. Engineer may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.
   7. Contractor shall bear costs of retests on defective welds.
   8. Contractor shall also bear costs in connection with qualifying welders.

B. Certification:
   1. Steel fabricators shall be certified by the AISC or other certification acceptable to the local building official having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver structural steel free from mill scale, rust, and pitting.

B. Storage and protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.
PART 2  PRODUCTS

2.01  MATERIALS

A. Unless otherwise specified or indicated on the Drawings, materials shall conform to the following:

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<tr>
<th>Item</th>
<th>ASTM Standard</th>
<th>Class, Grade, Type, or Alloy Number</th>
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<td>Steel</td>
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<tr>
<td>Plate, bars, rolled shapes (except W and WT shapes), and miscellaneous items</td>
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<tr>
<td>Rolled W and WT shapes</td>
<td>A992</td>
<td>Grade 50</td>
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<tr>
<td>Hollow structural sections (HSS): Round, square, or rectangular</td>
<td>A500</td>
<td>Grade B</td>
</tr>
<tr>
<td>Round HSS</td>
<td>A500</td>
<td>Grade B</td>
</tr>
<tr>
<td>Steel pipe</td>
<td>A53</td>
<td>Grade B</td>
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<tr>
<td>Stainless Steel</td>
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</tr>
<tr>
<td>Plate, sheet, and strip</td>
<td>A240</td>
<td>Type 304* or 316**</td>
</tr>
<tr>
<td>Bars and shapes</td>
<td>A276</td>
<td>Type 304* or 316**</td>
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* Use Type 304L if material will be welded.
** Use Type 316L if material will be welded.

B. Where stainless steel is welded, use low-carbon stainless steel.

2.02  FASTENERS AND STRUCTURAL HARDWARE

A. General:
2. Where fasteners and hardware are specified to be galvanized, galvanize in accordance with ASTM A153 or ASTM F2329.

B. All thread rods:
1. Uncoated:
   a. In accordance with ASTM A36 unless otherwise indicated on the Drawings.
2. Galvanized:
   a. In accordance with ASTM A36 unless otherwise indicated on the Drawings, and hot dip galvanized in accordance with ASTM A153.
3. Stainless steel:
   a. Units descaled, pickled, and passivated as specified in "Fabrication" in this Section.
   b. Threaded rods and nuts to be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship all thread rods with properly fitting nuts attached.
   c. Alloy Type 304 or Type 316 as indicated on the Drawings.
   d. Type 304:
      1) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
      3) Washers: Type 304 stainless steel.
   e. Type 316:
      1) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
      3) Washers: Type 316 stainless steel.

C. Anchor bolts, anchor rods, and post-installed steel anchors: As indicated on the Drawings and as specified in Section 05190.

D. High-strength bolts:
   1. Provide high-strength bolt assembly, with nuts, hardened flat washers, and compressible-washer-type direct tension indicators. Provide uncoated components unless galvanized coating is indicated on the Drawings.
   2. Uncoated:
      a. Bolts: Plain heavy hex structural bolts in accordance with ASTM A325 Type 1 indicated on the Drawings.
      b. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade C.
      c. Washers: Flat:
         1) Adjacent to normal, oversized, and short-slotted holes: Circular and square or rectangular beveled washers in accordance with ASTM F436.
         2) Adjacent to long slotted holes: 5/16-inch thick plate washer fabricated from steel in accordance with ASTM A36.
      d. Washers: Tension indicating: In accordance with ASTM F959.
   3. Galvanized:
      a. Bolt and nut assemblies fabricated, galvanized, tested for rotational capacity, and shipped accordance with the provisions ASTM A325 and the RCSC Specification.
      b. Bolts, nuts, and washers: Hot-dip galvanized and in accordance with ASTM A153, Class C or ASTM F2329.
      c. Bolts: Plain heavy hex structural bolts in accordance with ASTM A325 Type 1 and galvanized as specified.
      d. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade DH, galvanized as specified, and lubricated in accordance with ASTM A563, Supplementary Requirement S1 to minimize galling.
      e. Washers:
         1) Adjacent to normal, oversized, and short-slotted holes: Circular and square or rectangular beveled washers in accordance with ASTM F436 and galvanized as specified.
         2) Adjacent to long slotted holes: 5/16 inch thick plate washer fabricated from steel in accordance with ASTM A36, and galvanized in accordance with ASTM A123.
4. Direct-tension indicators.
   a. For each high-strength bolt at slip-critical connections, provide compressible washer type direct tension indicator in accordance with ASTM F959.

E. Welded studs: As indicated on the Drawings and as specified in Section 05190.

2.03 ISOLATING SLEEVES AND WASHERS

A. As indicated on the Drawings and as specified in Section 05190.

2.04 GALVANIZED SURFACE REPAIR

A. Manufacturers: One of the following or Engineer approved equal:
   1. Galvinox.
   2. Galvo-Weld.

2.05 THREAD COATING

A. Manufacturers: One of the following or Engineer approved equal:
   1. Never Seez Compound Corporation, Never-Seez.
   2. Oil Research, Inc., WLR No. 111.

2.06 SUPPLEMENTARY PARTS

A. Furnish as required for complete structural steel erection, whether or not such parts and Work are specified or indicated on the Drawings.

2.07 FABRICATION

A. Shop assembly:
   1. Fabricate structural steel in accordance with AISC 360 and AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
   2. Where anchors, connections, or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
   3. Round off sharp and hazardous projections and grind smooth.
   4. Take measurements necessary to properly fit work in the field. Take responsibility for and be governed by the measurements and proper working out of all the details.
   5. Take responsibility for correct fitting of all metalwork.

B. Stainless steel shapes and assemblies:
   1. For structural members such as W shapes, S shapes, channels, angles, and similar rolled shapes not available in quantity, size, and type of stainless steel specified or indicated on the Drawings:
      a. Fabricate shapes using laser-fused, full penetration welds between pieces of plate to attain same or higher section modulus and moment of inertia as that of members indicated on the Drawings.
      b. Fabricate shapes from dual grade stainless steel.
      c. Fabricate beams and channels to ASTM A6 tolerances.
      d. Manufacturers: The following, or Engineer approved equal:
         1) Stainless Structurals, LLC, Jacksonville, FL.
2. Cleaning and passivation:
   a. Following shop fabrication of stainless steel members and bolts, clean and passivate fabrications at point of manufacture.
   b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a bright passive finished surface with no etching, pitting, frosting, or discoloration.
   c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
      1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
   d. Pre-clean, chemically de-scale ("pickle"), passivate, and final-clean fabrications in accordance with the requirements of ASTM A380.
      1) If degreasing is required before cleaning (pickling) to remove scale or iron oxide, cleaning with citric acid treatments is permissible; however, such treatments shall be followed inorganic cleaners.
      2) Pickle and passivate stainless steel using a nitric acid solution in accordance with ASTM A380, Annex A2, Table A2.1, Part II.
      3) Pickling by citric acid treatment or sulfuric acid treatment is not considered to satisfy the requirements of this Section.
   e. Inspect after cleaning using methods specified for "gross inspection" in ASTM A380.
   f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the site.

C. Galvanized steel:
   1. Where galvanizing is required, hot-dip structural steel after fabrication in accordance with ASTM A123.
   2. Do not electro-galvanize or mechanically-galvanize unless specified or accepted by Engineer.
   3. Re-straighten galvanized items that bend or twist during galvanizing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 ERECTION

A. General:
   1. Fabricate structural and foundry items to true dimensions without warp or twist.
   2. Form welded closures neatly, and grind off smooth where weld material interferes with fit or is unsightly.
   3. Install structural items accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.
   4. Do not cock out of alignment, re-drill, re-shape, or force fit fabricated items.
5. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and level.
6. Rigidly support and brace structural items needing special alignment to preserve straight, level, even, and smooth lines. Keep structural items braced until concrete, grout, or dry pack mortar has hardened for 48 hours minimum.
7. Erect structural steel in accordance with AISC 360 unless otherwise specified or modified by applicable regulatory requirements.
8. Where anchors, connections, and other details of structural steel erection are not specifically indicated on the Drawings or specified, form, locate, and attach with equivalent in quality and workmanship to items specified.
9. Round off sharp or hazardous projections and grind smooth.
10. Paint or coat steel items as specified in Sections 09960.

B. Stainless steel. Take all necessary precautions to avoid iron contamination of stainless steel during delivery, storage, and handling.
   1. Segregate stainless steel from iron.
   2. Tools and handling devices.
      a. Do not use iron tools clamps, chokes, working surfaces, or brushes when fabricating, handling, and erecting stainless steel.
      b. Do not use tools that have been contaminated by contact with iron.
      c. Use stainless steel, polymer coated, or wood tools and handling equipment. Do not use tools that have been contaminated by contact with iron or steel.

C. Welding: General:
   1. Make welds full penetration type, unless otherwise indicated on the Drawings.
   2. Remove backing bars and weld tabs after completion of weld. Repair defective welds observed after removal of backing bars and weld tabs.

D. Welding stainless steel:
   1. General: In accordance with AWS D1.6.
   2. Field welding of stainless steel will not be permitted.
   3. Passivation of field-welded surfaces:
      a. Provide cleaning, pickling, and passivating as specified under "Fabrications" of this Section. Clean using Derustit Stainless Steel Cleaner, or Engineer approved equal.

E. Welding carbon steel:
   1. General: In accordance with AWS D1.1:
      a. Weld ASTM A36 and A992 structural steel, ASTM A500 and A501 structural tubing, and ASTM A53 pipe with electrodes conforming to AWS A5.1, using E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes:
      b. Field repair cut or otherwise damaged galvanized surfaces to equivalent original condition using a galvanized surface repair.

F. Interface with other products:
   1. Where steel members and fasteners come in contact with dissimilar metals (aluminum, stainless steel, etc.), separate, or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190.
G. Fasteners: General:
   1. Install bolts to project 2 threads minimum, but 1/2 inch maximum beyond nut.
   2. Anchor bolts and anchor rods: Install as specified in Section 05190.
      a. Unless otherwise specified, tighten nuts on anchor bolts and anchor rods specified in Section 05190 to the "snug-tight" condition.
   3. All thread rods in drilled holes and bonded to masonry with epoxy: Install as specified in Section 05190.

H. Fasteners: High-strength bolts:
   1. Connections with high-strength bolts shall in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
   2. Provide slip-critical joints at bolted connections.
      a. Confirm that faying surfaces at connections are free of dirt and other foreign material, have been blast cleaned, and are free of coatings and inadvertent overspray in accordance with RCSC Specification.
      b. Furnish hardened flat washers in accordance with ASTM F436:
         1) On outer plies with slotted holes.
         2) When 1 or more plies of the connected material has a yield strength less than 40 ksi.
         3) Under element, nut, or bolt head, turned in tightening.
      c. Install tension indicator washers, placed in accordance with ASTM F959 Figure X1, to confirm adequate tightening of bolts.
      d. Tighten bolts to full pretension for a slip critical joint.

I. Fasteners: Stainless steel bolts:
   1. Connections shall be snug-tight joints unless otherwise indicated on the Drawings.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.
   3. Rotate nuts using a slow, smooth action without interruptions. Avoid overtightening.

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cast-in anchors and fasteners:
      a. Anchor bolts.
      b. Anchor rods.
      c. Concrete inserts.
      d. Deformed bar anchors.
      e. Welded studs.
   2. Post-installed steel anchors and fasteners:
      a. Concrete anchors.
      b. Sleeve anchors.
   3. Appurtenances for anchoring and fastening:
      a. Anchor bolt sleeves.
      b. Isolating sleeves and washers.
      c. Thread coating for threaded stainless steel fasteners.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary.

B. American National Standards Institute (ANSI):

C. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):

1. AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.
2. AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry.
3. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 DEFINITIONS

A. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.

B. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.

C. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 60 degrees above a horizontal line so that the fastener resists sustained tension loads.

D. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.

E. Post-installed anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.

F. Terms relating to structures or building environments as used with reference to anchors and fasteners:

1. Corrosive locations: Describes interior and exterior locations as follows:
   a. Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
b. Exterior and interior locations at the following treatment structures.
   1) Wastewater treatment facilities: Liquids stream:
      a) Raw wastewater delivery and holding structures.
      b) Headworks and grit facilities.
      c) Primary clarifiers and primary clarifier flow splitting boxes.
   2) Wastewater treatment facilities: Solids stream:
      a) Sludge holding and thickening tanks.
      b) Digesters.
      c) Dewatering facilities.

2. Wet and moist locations: Describes locations, other than "corrosive locations," that are submerged, are immediately above liquid containment structures, or are subject to frequent wetting, splashing, or wash down. Includes:
   a. Exterior portions of buildings and structures.
   b. Liquid-containing structures:
      1) Locations at and below the maximum operating liquid surface elevation.
      2) Locations above the maximum operating liquid surface elevation and:
         a) Below the top of the walls containing the liquid.
         b) At the inside faces and underside surfaces of a structure enclosing or spanning over the liquid (including walls, roofs, slabs, beams, or walkways enclosing the open top of the structure).
   c. Liquid handling equipment:
      1) Bases of pumps and other equipment that handles liquids.
   d. Indoor locations exposed to moisture, splashing or routine wash down during normal operations, including floors with slopes toward drains or gutters.
   e. Other locations indicated on the Drawings.

3. Other locations:
   a. Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

1.04 SUBMITTALS

A. General:
   2. Submit information listed for each type of anchor or fastener to be used.

B. Action submittals:
   1. Product data:
      a. Cast-in anchors.
         1) Manufacturer's data including catalog cuts showing anchor sizes and configuration, materials, and finishes.
      b. Post-installed anchors:
         1) For each anchor type, manufacturer's data including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.
   2. Samples:
      a. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.
3. Certificates:
   a. Cast-in anchors:
      1) Mill certificates for steel anchors that will be supplied to the site.
   b. Post-installed anchors:
      1) Manufacturer’s statement or certified test reports demonstrating that
         anchors that will be supplied to the site comply with the materials
         properties specified.

4. Test reports:
   a. Post-installed anchors: For each anchor type used for the Work:
      1) Current ICC-ES Report (ESR) demonstrating:
         a) Acceptance of that anchor for use under the building code
            specified in Section 01410.

5. Manufacturer’s instructions.
   a. Requirements for storage and handling.
   b. Recommended installation procedures including details on drilling, hole
      size (diameter and depth), hole cleaning and preparation procedures,
      anchor insertion, and anchor tightening.
   c. Requirements for inspection or observation during installation.

6. Qualification statements.
   a. Post-installed anchors: Installer qualifications:
      1) Submit list of personnel performing installations and include date of
         manufacturer's training for each.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Post installed anchors shall be in accordance with building code specified in
      Section 01410.
   2. Installers: Post-installed mechanical anchors:
      a. Conduct a training session with the manufacturer's authorized technical
         representative for the project on-site:
         1) Training shall cover the complete installation process for each type of
            anchor to be used and shall include, but not be limited to hole drilling
            procedures and techniques; hole preparation and cleaning; bolt
            installation; and bolt proof loading and torqueing.
         2) Use only trained and qualified personnel for anchor installation.
      b. Installations shall be performed by trained installers having at least
         3 years' experience performing similar installations with similar types of
         anchors.

B. Special inspection:
   1. Provide special inspection of post-installed anchors as specified in
      Section 01455 and this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver post-installed anchors in manufacturer's standard packaging with labels
   visible and intact. Include manufacturer's installation instructions.

B. Handle and store anchors and fasteners in accordance with manufacturer's
   recommendations and as required to prevent damage.

C. Protect anchors from weather and moisture until installation.
1.07 PROJECT CONDITIONS

A. As specified in Section 01610.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. General:
1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor.
   a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
   b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings or as specified in this Section. In the event of conflicts, contact Engineer for clarification.
3. Where anchors and connections are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.

B. Materials:
1. Provide and install anchors of materials as in this Section.

2.02 CAST-IN ANCHORS AND FASTENERS

A. Anchor bolts:
1. Description:
   a. Straight steel rod having one end with integrally forged head, and one threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.
   b. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to Engineer.
      1) Rods or bars with angle bend for embedment in concrete (i.e.: "L" or "J" shaped anchor bolts) are not permitted in the Work.
2. Materials:
   a. Ship anchor bolts with properly fitting nuts attached.
   b. Type 316 stainless steel:
      1) Surfaces descaled, pickled, and passivated in accordance with ASTM A308.
      2) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
      3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
      4) Washers: Type 316 stainless steel.
c. Type 304 stainless steel:
   1) Surfaces descaled, pickled, and passivated in accordance with ASTM A308.
   2) Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
   3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
   4) Washers: Type 304 stainless steel.

d. Galvanized steel:
   1) Hot-dip galvanized coating in accordance with ASTM F2329.
   2) Bolt: ASTM F1554, Grade 36, heavy hex, coarse thread.
   3) Nuts: ASTM A563, Grade A, heavy hex, threads to match bolt.
   4) Washers: ASTM F436, Type 1.

B. Anchor rods:
1. Description: Straight steel rod having threads on each end or continuously threaded from end to end. One threaded end is fitted with nuts or plates and embedded in concrete to the effective depth indicated on the Drawings, leaving the opposite threaded end to project clear of the concrete face as required for the connection to be made at that location.

2. Materials:
   a. Stainless steel: Type 316:
      1) Surfaces descaled, pickled, and passivated in accordance with ASTM A308.
      2) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
      3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of rods.
      4) Washers: Type 316 stainless steel.
   b. Stainless steel: Type 304:
      1) Surfaces descaled, pickled, and passivated in accordance with ASTM A308.
      2) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
      3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of rods.
      4) Washers: Type 304 stainless steel.
   c. Galvanized:
      1) Hot-dip galvanized with coating in accordance with ASTM F2329.
      2) Rod: ASTM F1554, Grade 36 Grade, coarse thread.
      3) Nuts: ASTM A563, Grade A Grade, threads to match rod.
      4) Washers: ASTM F436, Type 1.

C. Concrete insert: Ductile embed:
1. Description: 1-piece, integrally hot forged sleeve for embedment in concrete. Provided with flange for nailing to forms and female threaded coupler at the exposed concrete face, and washer-faced hex headed foot to resist pullout from concrete at the embedded end.

2. Manufacturers: One of the following or Engineer approved equal:
   a. Dayton Superior: F-54 Ductile Embed Insert.
3. **Materials:**  
   a. Stainless steel: Not available.  
   b. Galvanized steel:  
      1) Hot-dip galvanized coating in accordance with ASTM A123 or A153 where indicated on the Drawings.  
      2) Steel: ASTM A29 hot rolled, Grade 1045.

D. **Deformed bar anchors:**  
   1. **Description:** Steel rod with rebar-like deformations along its length and welding ferrule at one end for attachment to structural steel members (plates or shapes).  
   2. **Manufacturers:** One of the following or Engineer approved equal:  
   3. **Materials:**  
      a. Stainless steel: Not available.  
      b. Galvanized steel:  
         1) Hot dip galvanized coating in accordance with ASTM A153 where indicated on the Drawings.  
         2) Steel: ASTM A496 wire deformed for concrete reinforcement.

E. **Welded studs:**  
   1. **Description:** Anchor with forged head for embedment into concrete on one end, and welding ferrule for attachment to steel on the other. Welded to steel members or plates to provide anchorage for steel connections to concrete.  
   2. **Acceptance criteria:**  
      a. Welded studs in accordance with AWS D1.1, Type B.  
   3. **Manufacturers:** One of the following or Engineer approved equal:  
      a. Nelson Stud Welding Company: H4L Concrete Anchors or S3L Shear Connectors as indicated on the Drawings.  
      b. Stud Welding Products: Headed Concrete Anchors (HCA) or Headed Shear Connectors (HSC) as indicated on the Drawings.  
   4. **Materials:**  
      a. Stainless steel: Type 316L.  
      b. Stainless steel: Type 304L.  
      c. Galvanized steel:  
         1) Hot-dip galvanized after fabrication with coating in accordance with ASTM A123.  
         2) Steel: Carbon steel in accordance with ASTM A108 with 50,000-pounds per square inch minimum yield strength, and 60,000-pounds per square inch minimum tensile strength.

F. **Steel plates or shapes for fabrications including assemblies with welded studs or deformed bar anchors:**  
   1. **Stainless steel:** Type 316L or Type 304L:  
   2. **Galvanized steel:**  
      a. Hot dip galvanized in accordance with ASTM A123.  
      b. Steel: ASTM A36.
2.03 POST-INSTALLED ANCHORS AND FASTENERS – ADHESIVE

A. Epoxy reinforcing bars, all thread rods, and threaded inserts in Concrete Masonry Units:
   1. Adhesive shall have a current Evaluation Report demonstrating compliance with the requirements of ICC-ES AC58.
   2. Materials:
      a. 2-component structural adhesive, insensitive to moisture, and gray in color.
      b. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.
   3. Packaging:
      a. Furnished in disposable, side-by-side cartridges with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle.
      b. Nozzle designed to thoroughly blend the components, in the proper mixing ratio, for injection from the nozzle directly into prepared hole.
      c. Provide nozzle extensions as required to allow full-depth insertion and filling from the bottom of the hole.
   4. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
   5. For installation in solid masonry and solid-grouted masonry (concrete or brick):
   6. Manufacturers: One of the following or Engineer approved equal:

2.04 POST-INSTALLED ANCHORS AND FASTENERS – MECHANICAL

A. General:
   1. Post-installed anchors used for the Work shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01410.
      a. Conditions of use: The acceptance report shall indicate acceptance of the product for use under the following conditions:
         1) In regions of concrete where cracking has occurred or may occur.
         2) To resist short-term loads due to wind forces.
         3) To resist short-term loading due to seismic forces for the Seismic Design Category of the structure where the product will be used.
   B. Concrete anchors:
      1. Description. Post-installed anchor assembly consisting of a threaded stud and a surrounding wedge expansion sleeve that is forced outward by torqueing the center stud to transfer loads from the stud to the concrete through bearing, friction, or both. (Sometimes referred to as "expansion anchors" or "wedge anchors.")
         a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials to develop holding power.
2. Concrete anchors for anchorage to concrete:
   a. Acceptance criteria:
      1) Concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
      2) Concrete anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.
   b. Manufacturers: One of the following or Engineer approved equal:
      1) Hilti: Kwik Bolt TZ Expansion Anchor.
      3) Simpson Strong-Tie ®: Strong Bolt 2 Wedge Anchor.
   c. Materials. Integrally threaded stud, wedge, washer and nut:
      1) Stainless steel: Type 316.
         a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.
      2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

C. Flush shells:
   1. Description: Post-installed anchor assembly consisting of an internally threaded mandrel that is forced into a pre-drilled concrete hole with a setting tool until the top of the anchor is flush with the face of the concrete. Once installed, a removable threaded bolt is installed in the mandrel.
   2. Flush shell anchors are not permitted in the Work.

D. Sleeve anchors:
   1. Description: Post-installed, torque-controlled anchor assembly consisting of an externally threaded stud with a spacer sleeve near the surface of the base material, and an expansion sleeve on the lower part of the stud. The expansion sleeve is forced outward by torqueing of the center stud to transfer load.
      a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials in order to develop holding power.
   2. Sleeve anchors for anchorage to concrete:
      a. Acceptance criteria:
         1) Sleeve anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
         2) Sleeve anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.
      b. Manufacturers: One of the following or Engineer approved equal:
         1) Hilti: HSL-3 Heavy Duty Expansion (sleeve) Anchor.
c. Materials:
   1) Stainless steel: Not available.
   2) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

2.05 APPURTENANCES FOR ANCHORING AND FASTENING

A. Anchor bolt sleeves:
   1. Having inside diameter approximately 2 inches greater than bolt diameter and minimum 10-bolt diameters long.
   2. Plastic sleeves:
      a. High-density polyethylene, corrugated sleeve, threaded to provide adjustment of location on the anchor bolt.

B. Isolating sleeves and washers:
   1. Manufacturers: One of the following or Engineer approved equal:
      b. Corrosion Control Products, PSI Inc., Gardena, CA.
   2. Sleeves: Mylar, 1/32 inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending half way into both steel washers.
   3. One sleeve required for each bolt.
   4. Washers: The inside diameter of all washer shall fit over the isolating sleeve and both the steel and isolating washers shall have the same inside diameter and outside diameter.
      a. Proper size to fit bolts. 2 insulating washers are required for each bolt.
      b. Two 1/8 inch thick steel washers for each bolt.
      c. G3 Phenolic:
         1) Thickness: 1/8 inch.
         2) Base material: Glass.
         3) Resin: Phenolic.
         4) Water absorption: 2 percent.
         5) Hardness (Rockwell): 100.
         6) Dielectric strength: 450 volts per mil.
         7) Compression strength: 50,000 pounds per square inch.
         8) Tensile strength: 20,000 pounds per square inch.
         9) Maximum operating temperature: 350 degrees Fahrenheit.

C. Coating for repair of galvanized surfaces:
   1. Manufacturers: One of the following or Engineer approved equal:
      a. Galvinox.
      b. Galvo-Weld.

D. Thread coating: For use with threaded stainless steel fasteners:
   1. Manufacturers: One of the following or Engineer approved equal:
      b. Oil Research, Inc., WLR No. 111.
PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION: GENERAL

A. Where anchors and fasteners are not specifically indicated on the Drawings or specified, make attachments with materials specified in this Section.

B. Substitution of anchor types:
   1. Post-installed anchors may not be used as an alternative to cast-in/built-in anchors at locations where the latter are indicated on the Drawings.
   2. Cast-in/built-in anchors may be used as an alternative to post-installed mechanical anchors at locations where the latter are indicated on the Drawings.

C. Protect products from damage during installation. Take special care to protect threads and threaded ends.

D. Accurately locate and position anchors and fasteners:
   1. Unless otherwise indicated on the Drawings, install anchors perpendicular to the surfaces from which they project.
   2. Install anchors so that at least 2 threads, but not more than 1/2 inch of threaded rod, projects past the top nut.

E. Interface with other products:
   1. Where steel anchors come in contact with dissimilar metals (aluminum, stainless steel, etc.), use stainless steel anchors and separate or isolate dissimilar metals using isolating sleeves and washers.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

3.03 INSTALLATION: CAST-IN ANCHORS

A. General:
   1. Accurately locate cast-in and built-in anchors.
      a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.
      b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.
      c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not "stab" anchors into plastic concrete, mortar, or grout.
      d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.
   2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.

**B. Anchor bolts:**
1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.
2. Where indicated on the Drawings, set anchor bolts in plastic, galvanized steel or stainless steel sleeves to allow for adjustment. Seal top of sleeve to prevent grout from filling sleeve.

**C. Anchor rods:**
1. Install as specified for anchor bolts.

**D. Concrete inserts:**
1. Provide inserts with minimum clear concrete cover not less than that specified for reinforcing bars.

**E. Deformed bar anchors:**
1. Butt weld to steel fabrications with automatic stud welding gun as recommended by manufacturer.
2. Ensure that butt weld develops the full strength of the anchor.

**F. Welded studs:**
1. Butt weld to steel fabrications with automatic stud welding gun as recommended by the manufacturer.
2. Ensure that butt weld develops full strength of the stud.

### 3.04 INSTALLATION: POST-INSTALLED MECHANICAL ANCHORS

**A. General:**
1. Install anchors in accordance with the manufacturer's instructions, ACI 355.2, the anchor's ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements in this Section, the requirements of the ICC-ES Report shall control.
2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.
3. After anchors have been positioned and inserted into concrete or masonry, do not:
   a. Remove and reuse/reinstall anchors.
   b. Loosen or remove bolts or studs.

**B. Holes drilled into concrete and masonry:**
1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength (f'c or f'm).
2. Accurately locate holes:
   a. Before drilling holes, use a reinforcing bar locator to identify the position of all reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.
b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.

3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry.
   a. If embedments are encountered during drilling, immediately stop work and notify the Engineer. Await Engineer's instructions before proceeding.

4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.

5. Drill using anchor manufacturer's recommended equipment and procedures.
   a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
      1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
      2) Drill bits: Carbide-tipped in accordance with ANSI B212-15. Hollow drills with flushing air systems are preferred.

6. Drill holes at manufacture's recommended diameter and to depth required to provide the effective embedment indicated.

7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor.
   a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
   b. Repeat cleaning process as required by the manufacturer's installation instructions.
   c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

C. Insert and tighten (or torque) anchors in full compliance with the manufacturer's installation instructions.
   1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

<table>
<thead>
<tr>
<th>Nominal Diameter</th>
<th>Minimum Effective Embedment Length</th>
<th>Minimum required member thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In concrete</td>
<td>In grouted masonry</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>2-1/2 inch</td>
<td>2-5/8 inch</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>3-1/2 inch</td>
<td>3-1/2 inch</td>
</tr>
<tr>
<td>5/8 inch</td>
<td>4-1/2 inch</td>
<td>4-1/2 inch</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>5 inch</td>
<td>5-1/4 inch</td>
</tr>
</tbody>
</table>

E. Flush shell anchors:
   1. Flush shell anchors are not permitted in the Work.
   2. If equipment manufacturer's installation instructions recommend the use of flush shell anchors, contact Engineer for instructions before proceeding.
F. Sleeve anchors:
   1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

<table>
<thead>
<tr>
<th>Nominal Diameter</th>
<th>Minimum Effective Embedment Length</th>
<th>Minimum Member Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In concrete</td>
<td>In grouted masonry</td>
</tr>
<tr>
<td>M8 (1/2 inch)</td>
<td>70 mm (2-3/4 inch)</td>
<td>Not accepted</td>
</tr>
<tr>
<td>M10 (5/8 inch)</td>
<td>76 mm (3 inch)</td>
<td>Not accepted</td>
</tr>
<tr>
<td>M12 (3/4 inch)</td>
<td>80 mm (3-1/4 inch)</td>
<td>Not accepted</td>
</tr>
</tbody>
</table>

2. Install with the sleeve fully engaged in the base material.

G. Anchoring to Concrete Masonry Units:
   1. Drilling holes:
      a. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device. Mark locations with on the surface of the masonry using removable construction crayon, or other method acceptable to the Engineer.
      b. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the masonry without prior acceptance by Engineer.
   2. Hole drilling equipment:
      a. Electric or pneumatic rotary impact type.
         1) Set drill to "rotation only" mode, or to "rotation plus hammer" mode in accordance with manufacturer's installation instructions and the requirements of the Evaluation Report.
      b. Where edge distances are less than 2 inches and "rotation plus hammer" mode is permitted, use lighter impact equipment to prevent micro-cracking and spalling from drilling.
   3. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.
   5. Hole depth: As recommended by the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings.
   6. Obstructions in drill path.
   7. If an existing reinforcing bar or other obstruction is hit while drilling hole, stop drilling and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill to the required depth.
      a. Allow dry-pack mortar to cure to strength equal to that of the surrounding masonry before resuming drilling in that area.
      b. Epoxy grout may be substituted for dry-pack mortar when acceptable to the Engineer.
   8. Avoid drilling an excessive number of adjacent holes that would weaken the structural member and endanger the stability of the structure. Obtain Engineer's acceptance of distance between abandoned and relocated holes.
   9. Cleaning holes:
      a. Insert air nozzle to bottom of hole and blow out loose dust.
         1) Use compressed air that is free of oil, water, or other contaminants.
2) Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
   b. Using a stiff bristle brush of diameter that provides contact around the full perimeter of the hole, vigorously brush the hole to dislodge compacted drilling dust.
      1) Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
      2) Repeat at least 4 times.
   c. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and as required by the manufacturer and the Evaluation Report.
   d. Leave prepared hole clean and dry.

3.05 FIELD QUALITY CONTROL

A. Contractor shall provide quality control over the Work of this Section as specified in Section 01450.
   1. Expenses associated with work described by the following paragraphs shall be paid by the Contractor.

B. Post-installed anchors:
   1. Review anchor manufacturer's installation instructions and requirements of the Evaluation Service Report (hereafter referred to as "installation documents") for each anchor type and material.
   2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
   3. Certify in writing to the Engineer that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.06 FIELD QUALITY ASSURANCE

A. Owner's Representative will provide on-site observation and field quality assurance for the Work of this Section.
   1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.

B. Field inspections and special inspections:
   1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted submittals, and manufacturer's installation instructions for the products used.
   2. Record of inspections:
      a. Maintain record of each inspection.
      b. Submit copies to Engineer upon request.
   3. Statement of special inspections: At the end of the project, prepare and submit to the Engineer and the authority having jurisdiction inspector's statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.
C. Special inspections: Anchors cast into concrete and built into masonry.
   1. Provide special inspection during positioning of anchors and placement of concrete or masonry (including mortar and grout) around the following anchors:
      a. Anchor bolts.
      b. Anchor rods.
      c. Concrete inserts (all types).
      d. Deformed bar anchors.
      e. Welded studs.
   2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents.
      a. Anchor:
         1) Type and dimensions.
         2) Material: Galvanized steel, Type 304 stainless steel, or Type 316 stainless steel as specified in this Section or indicated on the Drawings.
         3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
         4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.
   3. Following hardening and curing of the concrete or masonry surrounding the anchors, provide periodic special inspection to observe and confirm the following:
      a. Base material (concrete or grouted masonry):
         1) Solid and dense concrete or grouted masonry material within required distances surrounding anchor.
         2) Material encapsulating embedment is dense and well-consolidated.

D. Special Inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry.
   1. Provide special inspection during installation of the following anchors:
      a. Concrete anchors.
      b. Sleeve anchors.
   2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torqueing of anchors.
      a. Provide continuous special inspection for post-installed anchors in "overhead installations" as defined in this Section.
   3. Requirements for periodic special inspection:
      a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for the anchor being used. Observe the initial installation of each type and size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours.
         1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor, shall require a new "initial inspection."
      b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor's rated strength.
      c. Anchor:
         1) Manufacturer, type, and dimensions (diameter and length).
         2) Material (galvanized, Type 304 stainless steel, or Type 316 stainless steel).
d. Hole:
   1) Positioning: Spacing and edge distances.
   2) Drill bit type and diameter.
   3) Diameter, and depth.
   4) Hole cleaned in accordance with manufacturer's required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
   5) Anchor's minimum effective embedment.
   6) Anchor tightening/installation torque.

4. Requirements for continuous special inspection:
   a. The special inspector shall observe all aspects of anchor installation, except that holes may be drilled in his/her absence provided that he/she confirms the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:
   1. Owner's Representative may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications.
      a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
      b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.

3.07 NON-CONFORMING WORK

A. Remove miss-aligned or non-performing anchors.

B. Fill empty anchor holes and repair failed anchor locations using high-strength, non-shrink, non-metallic grout.

C. If more than 10 percent of all tested anchors of a given diameter and type fail to achieve their specified torque, the Engineer will provide directions for required modifications. Make such modifications, up to and including replacement of all anchors, at no additional cost to the Owner.

3.08 SCHEDULES

A. Stainless steel. Provide and install stainless steel anchors at the following locations:
   1. "Corrosive locations" as defined in this Section: Type 316 stainless steel.
   2. "Other locations:"
      a. For connecting steel stainless steel members to concrete or masonry: Type 304 stainless steel.
      b. For connecting aluminum members to concrete or masonry.
      c. For connecting fiber-reinforced plastic (FRP) members to concrete or masonry.
   3. At locations indicated on the Drawings.
B. Galvanized: Provide and install galvanized carbon steel anchors at the following locations:
1. Locations not requiring stainless steel.
2. At locations indicated on the Drawings.

END OF SECTION
SECTION 09960
HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Field-applied coatings.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01600 - Product Requirements.

1.02 REFERENCES

A. ASTM International (ASTM):  

B. International Concrete Repair Institute (ICRI):  
   1. Guideline 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

C. NACE International (NACE):  
   2. SP0188 - Discontinuity (Holiday) Testing of Protective Coatings.

D. National Association of Pipe Fabricators (NAPF):  
   1. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.

E. NSF International (NSF):  
   1. 61 - Drinking Water System Components - Health Effects.

F. Society for Protective Coatings (SSPC):  
   1. SP COM - Surface Preparation Commentary for Steel and Concrete Substrates.  
   2. SP 1 - Solvent Cleaning.  
   3. SP 2 - Hand Tool Cleaning.  
   4. SP 3 - Power Tool Cleaning.  
   5. SP 5 - White Metal Blast Cleaning.  
   6. SP 6 - Commercial Blast Cleaning.  
   7. SP 7 - Brush-Off Blast Cleaning.  
   8. SP 10 - Near-White Blast Cleaning.  
   9. SP 13 - Surface Preparation of Concrete.
G. United States Environmental Protection Agency (EPA):
   1. Method 24 - Surface Coatings.

1.03 DEFINITIONS

A. Submerged metal: Steel or iron surfaces below tops of channel or structure walls that will contain water even when above expected water level.

B. Submerged concrete and masonry surfaces: Surfaces that are or will be:
   1. Underwater.
   2. In structures that normally contain water.

C. Exposed surface: Any metal or concrete surface, indoors or outdoors, that is exposed to view.

D. Dry film thickness (DFT): Thickness of fully cured coating, measured in mils.

E. Volatile organic compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.

F. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.

G. Where SSPC surface preparation standards are specified or implied for ductile iron pipe or fittings, the equivalent NAPF surface preparation standard shall be substituted for the SSPC standard.

1.04 PERFORMANCE REQUIREMENTS

A. Coating materials shall be especially adapted for use in wastewater treatment plants.

1.05 SUBMITTALS

A. General: Submit as specified in Contract Documents.

B. Shop drawings:
   1. Schedule of proposed coating materials.
   2. Schedule of surfaces to be coated with each coating material.

C. Product data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips:
   1. Regulatory requirements: Submit data concerning the following:
      a. VOC limitations.
      b. Coatings containing lead compounds and polychlorinated biphenyls.
      c. Abrasives and abrasive blast cleaning techniques, and disposal.
      d. NSF certification of coatings for use in potable water supply systems.

D. Samples: Include 8-inch square drawdowns or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number, sheen name, and gloss units.
E. Certificates: Submit in accordance with requirements for Product Data.

F. Manufacturer's instructions: Include the following:
   1. Special requirements for transportation and storage.
   2. Mixing instructions.
   3. Shelf life.
   4. Pot life of material.
   5. Precautions for applications free of defects.
   7. Method of application.
   8. Recommended number of coats.
   9. Recommended DFT of each coat.
  10. Recommended total DFT.
  11. Drying time of each coat, including prime coat.
  12. Required prime coat.
  13. Compatible and non-compatible prime coats.
  14. Recommended thinners, when recommended.
  15. Limits of ambient conditions during and after application.
  16. Time allowed between coats (minimum and maximum).
  17. Required protection from sun, wind, and other conditions.
  18. Touch-up requirements and limitations.
  19. Minimum adhesion of each system submitted in accordance with ASTM D4541.

G. Manufacturer's Representative's Field Reports.

H. Operations and Maintenance Data: Submit as specified in Section 01782.
   1. Reports on visits to project site to view and approve surface preparation of structures to be coated.
   2. Reports on visits to project site to observe and approve coating application procedures.
   3. Reports on visits to coating plants to observe and approve surface preparation and coating application on items that are "shop coated."

I. Quality Assurance Submittals:
   1. Quality assurance plan.
   2. Qualifications of coating applicator including List of Similar Projects.

J. Certifications:
   1. Submit notarized certificate that:
      a. All paints and coatings to be used on this project comply with current federal, state, and local VOC regulations.

1.06 QUALITY ASSURANCE

A. Applicator qualifications:
   1. Minimum of 5 years of experience applying specified type or types of coatings under conditions similar to those of the Work:
      a. Provide qualifications of applicator and references listing 5 similar projects completed in the past 2 years.
   2. Manufacturer-approved applicator when manufacturer has approved applicator program.
3. Approved and licensed by elastomeric polyurethane (100-percent solids) manufacturer to apply 100-percent solids elastomeric polyurethane system.

B. Regulatory requirements: Comply with governing agencies regulations by using coatings that do not exceed permissible VOC limits and do not contain lead:
   1. Do not use coal-tar epoxy in contact with drinking water or exposed to ultraviolet radiation.

C. Certification: Certify that applicable pigments are resistant to discoloration or deterioration when exposed to hydrogen sulfide and other sewage gases and product data designates coating as suitable for wastewater service.

D. Field samples:
   1. Prepare and coat a minimum 100-square-foot area between corners or limits such as control or construction joints of each system.
   2. Approved field sample may be part of the Work.
   3. Obtain approval before painting other surfaces.

E. Compatibility of coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

F. Services of coating manufacturer's representative: Arrange for coating manufacturer's representative to attend pre-installation conferences. Make periodic visits to the project site to provide consultation and inspection services during surface preparation and application of coatings, and to make visits to coating plants to observe and approve surface preparation procedures and coating application of items to be "shop-primed and coated."

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products as specified in Section 01600.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver new unopened containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.
   1. Do not deliver materials aged more than 12 months from manufacturing date.

D. Store coatings in well-ventilated facility that provides protection from the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.08 PROJECT CONDITIONS

A. Surface moisture contents: Do not coat surfaces that exceed manufacturer-specified moisture contents, or when not specified by the manufacturer, with the following moisture contents:
   1. Plaster and gypsum wallboard: 12 percent.
   2. Masonry, concrete, and concrete block: 12 percent.
   3. Interior located wood: 15 percent.
   4. Concrete floors: 7 percent.
B. Do not apply coatings:
   1. Under dusty conditions or adverse environmental conditions, unless tenting, covers, or other such protection is provided for structures to be coated.
   2. When light on surfaces measures less than 15 foot-candles.
   3. When ambient or surface temperature is less than 55 degrees Fahrenheit unless manufacturer allows a lower temperature.
   4. When relative humidity is higher than 85 percent.
   5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
   6. When surface temperature exceeds the manufacturer’s recommendation.
   7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
   8. Apply clear finishes at minimum 65 degrees Fahrenheit.

C. Provide fans, heating devices, dehumidifiers, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.

D. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 55 degrees Fahrenheit for 24 hours before, during, and 48 hours after application of finishes.

1.09 MAINTENANCE

A. Extra materials: Include minimum 1 gallon of each type and color of coating applied:
   1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.
   2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type, and color.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Special coatings: One of the following or Engineer approved equal:
   1. Carboline: Carboline, St. Louis, MO.
   2. Ceilcote: International Protective Coatings, Berea, OH.
   3. Dampney: The Dampney Company, Everett, MA.
   4. Devoe: International Protective Coatings, Louisville, KY.
   5. Dudick: Dudick, Inc., Streetsboro, OH.
   6. GET: Global Eco Technologies, Pittsburg, CA.
   8. IET: Integrated Environmental Technologies, Santa Barbara, CA.
   9. PPC: Polymorphic Polymers Corp., North Miami, FL.
   10. PPG Amercoat: PPG Protective & Marine Coatings, Brea, CA.
   11. Rustoleum: Rustoleum Corp., Sommerset, NJ.
   12. Sanchem: Sanchem, Chicago, IL.
   13. Superior: Superior Environmental Products, Inc., Addison, TX.
   15. Tnemec: Tnemec Co., Kansas City, MO.
   16. Wasser: Wasser High Tech Coatings, Kent, WA.
   17. ZRC: ZRC Worldwide Innovative Zinc Technologies, Marshfield, MA.
2.02 PREPARATION AND PRETREATMENT MATERIALS

A. Metal pretreatment: As manufactured by one of the following or Engineer approved equal:
   2. International: AWLGrip Alumiprep 33.

B. Surface cleaner and degreaser: As manufactured by one of the following or Engineer approved equal:
   1. Carboline Surface Cleaner No. 3.

2.03 COATING MATERIALS

A. Alkali-resistant bitumastic: As manufactured by one of the following or Engineer approved equal:
   4. As specified for Coal Tar Epoxy Substitute.

B. Wax coating: As manufactured by the following or Engineer approved equal:
   1. Sanchem: No-Ox-Id A special.

C. High solids epoxy (self-priming) not less than 72 percent solids by volume: As manufactured by one of the following or Engineer approved equal:
   2. Devoe: Bar Rust 233H.
   3. PPG Amercoat: Amerlock 2.
   4. S-W: Macroxy 646.
   5. Tnemec: HS Epoxy Series 104.

D. Aliphatic or aliphatic-acrylic polyurethane: As manufactured by one of the following or Engineer approved equal:
   1. Carboline: Carbothane 134 VOC.
   2. Devoe: Devthane 379.
   3. PPG Amercoat: Amershield VOC.
   5. Tnemec: Endura-Shield II Series 1075 (U).

E. High-temperature coating 150 to 350 degrees Fahrenheit: As manufactured by one of the following or Engineer approved equal:
   3. PPG Amercoat: Amerlock 2/400 GFK.

F. High-temperature coating 400 to 1,000 degrees Fahrenheit (dry): As manufactured by one of the following or Engineer approved equal:
   1. Carboline: Thermaline 4700.
G. High-temperature coating up to 1,400 degrees Fahrenheit: As manufactured by the following or Engineer approved equal:

H. Asphalt varnish: AWWA C 500.

I. Coal tar: Where coal tar, coal-tar epoxy, or coal-tar mastic are specified or indicated on the Drawings, use coal-tar epoxy substitute in their place. Coal tar shall not be allowed.

J. Coal-tar epoxy substitute: As manufactured by one of the following or Engineer approved equal:
   1. Devoe: Devtar 5A HS.
   2. S-W: Macropoxy 646 Black.

K. Vinyl ester: Glass mat reinforced, total system 125 mils DFT. As manufactured by one of the following or Engineer approved equal:
   2. Ceilcote: 6640 Ceilcrete.
   3. Dudick: Protecto-Flex 800.
   4. Tnemec: Chembloc Series 239SC.

L. Elastomeric polyurethane, 100-percent solids, ASTM D 16, Type V, (Urethane P): As manufactured by the following or Engineer approved equal:

M. Concrete floor coatings: As manufactured by one of the following or Engineer approved equal:
   1. Carboline: Semstone 140SL.
   2. Devoe: Devran 124.
   3. Dudick: Polymer Alloy 1000.

N. Waterborne acrylic emulsion: As manufactured by one of the following or Engineer approved equal:

O. Galvanizing zinc compound: As manufactured by one of the following or Engineer approved equal:
   1. ZRC: Cold Galvanizing Compound.

2.04 MIXES

A. Mix in accordance with manufacturer’s instructions.

PART 3 EXECUTION

3.01 GENERAL PROTECTION

A. Protect adjacent surfaces from coatings and damage. Repair damage resulting from inadequate or unsuitable protection.
B. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings:
   1. Mask off surfaces of items not to be coated or remove items from area.

C. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and, in particular, surfaces within storage and preparation areas.

D. Place cotton waste, cloths, and material that may constitute a fire hazard in closed metal containers and remove daily from site.

E. Remove electrical plates, surface hardware, fittings, and fastenings prior to application of coating operations. Carefully store, clean, and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

3.02 GENERAL PREPARATION

A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements are specified in this Section.

B. Protect the following surfaces from abrasive blasting by masking or other means:
   1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
   2. Machined surfaces for sliding contact.
   3. Surfaces to be assembled against gaskets.
   4. Surfaces of shafting on which sprockets are to fit.
   5. Surfaces of shafting on which bearings are to fit.
   6. Machined surfaces of bronze trim, including slide gates.
   7. Cadmium-plated items except cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment requiring abrasive blasting.
   8. Galvanized items, unless scheduled to be coated.

C. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.

D. Concrete:
   1. Allow new concrete to cure for minimum of 28 days before coating.
   2. Clean concrete surfaces of dust, mortar, fins, loose concrete particles, form release materials, oil, and grease. Fill voids so that surface is smooth. Prepare concrete surface for coating in accordance with SSPC SP 13. Provide ICRI 310.2 CSP-3 surface profile, or as recommended by coating manufacturer. All concrete surfaces shall be vacuumed clean prior to coating application.

E. Ferrous metal surfaces:
   1. Remove grease and oil in accordance with SSPC SP 1.
   2. Remove rust, scale, and welding slag and spatter, and prepare surfaces in accordance with appropriate SSPC standard as specified.
   3. Abrasive blast surfaces prior to coating.
      a. When abrasive blasted surfaces rust or discolor before coating, abrasive blast surfaces again to remove rust and discoloration.
      b. When metal surfaces are exposed because of coating damage, abrasive blast surfaces and feather in to a smooth transition before touching up.
c. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC SP 10, unless blasting may damage adjacent surfaces, prohibited, or specified otherwise. Where not possible to abrasive blast, power tool clean surfaces in accordance with SSPC SP 3.

d. Ferrous metal surfaces to be submerged: Unless specified otherwise, abrasive blast in accordance with SSPC SP 5 to clean and provide roughened surface profile of not less than 2 mils and not more than 4 mils in depth when measured with Elcometer 123, or as recommended by the coating manufacturer.

4. All abrasive blast cleaned surfaces shall be blown down with clean dry air and/or vacuumed.

F. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.

G. Sherardized, aluminum, copper, and bronze surfaces: Prepare in accordance with coating manufacturer's instructions.

H. Galvanized surface:
   1. Degrease or solvent clean (SSPC SP 1) to remove oily residue.
   2. Power tool or hand tool clean or whip abrasive blast.
   3. Test surface for contaminants using copper sulfate solution.
   4. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded physically, such as bolts, nuts, or preformed channels.

I. Shop-primed metal:
   1. Certify that primers applied to metal surfaces in the shop are compatible with coatings to be applied over such primers in the field.
   2. Remove shop primer from metal to be submerged by abrasive blasting in accordance with SSPC SP 10, unless greater degree of surface preparation is required by coating manufacturer's representative.
   3. Correct abraded, scratched, or otherwise damaged areas of prime coat by sanding or abrasive blasting to bare metal in accordance with SSPC SP 2, SP 3, or SP 6, as directed by the Engineer. When entire shop priming fails or has weathered excessively (more than 25 percent of the item), or when recommended by coating manufacturer's representative, abrasive blast shop prime coat to remove entire coat and prepare surface in accordance with SSPC SP 10.
   4. When incorrect prime coat is applied, remove incorrect prime coat by abrasive blasting in accordance with SSPC SP 10.
   5. When prime coat not authorized by Engineer is applied, remove unauthorized prime coat by abrasive blasting in accordance with SSPC SP 10.
   6. Shop applied bituminous paint or asphalt varnish: Abrasive blast clean shop applied bituminous paint or asphalt varnish from surfaces scheduled to receive non-bituminous coatings.

J. Cadmium-plated, zinc-plated, or sherardized fasteners:
   1. Abrasive blast in the same manner as unprotected metal when used in assembly of equipment designated for abrasive blasting.

K. Abrasive blast components that are to be attached to surfaces that cannot be abrasive blasted before components are attached.
L. Grind sharp edges to approximately 1/16-inch radius before abrasive blast cleaning.

M. Remove and grind smooth all excessive weld material and weld spatter before blast cleaning in accordance with NACE SP0178.

N. Poly vinyl chloride (PVC) and FRP surfaces:
   1. Prepare surfaces to be coated by light sanding (de-gloss) and wipe-down with clean cloths, or by solvent cleaning in strict accordance with coating manufacturer's instructions.

O. Cleaning of previously coated surfaces:
   1. Utilize cleaning agent to remove soluble salts such as chlorides and sulfates from concrete and metal surfaces:
      a. Cleaning agent: Biodegradable non-flammable and containing no VOC.
      b. Manufacturer: The following or Engineer approved equal:
         1) CHLOR*RID International, Inc.
   2. Steam clean and degrease surfaces to be coated to remove oils and grease.
   3. Cleaning of surfaces utilizing the decontamination cleaning agent may be accomplished in conjunction with abrasive blast cleaning, steam cleaning, high-pressure washing, or hand washing as approved by the coating manufacturer's representative and the Engineer.
   4. Test cleaned surfaces in accordance with the cleaning agent manufacturer's instructions to ensure all soluble salts have been removed. Additional cleaning shall be carried out as necessary.
   5. Final surface preparation prior to application of new coating system shall be made in strict accordance with coating manufacturer's printed instructions.

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT PREPARATION

A. Identify equipment, ducting, piping, and conduit as specified in Section 16075.

B. Remove grilles, covers, and access panels for mechanical and electrical system from location and coat separately.

C. Prepare and finish coat primed equipment with color selected by the Engineer.

D. Prepare and prime and coat insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with prefinished coating.

E. Replace identification markings on mechanical or electrical equipment when coated over or spattered.

F. Prepare and coat interior surfaces of air ducts, and convector and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.

G. Prepare and coat dampers exposed immediately behind louvers, grilles, and convector and baseboard heating cabinets to match face panels.

H. Prepare and coat exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.
I. Prepare and coat both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

J. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming, and numbering, in accordance with the Contract Documents.

3.04 GENERAL APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Coat metal unless specified otherwise:
   1. Aboveground piping to be coated shall be empty of contents during application of coatings.

C. Verify metal surface preparation immediately before applying coating in accordance with SSPC SP COM.

D. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

E. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.

F. Prime shop-primed metal surfaces. Spot prime exposed metal of shop-primed surfaces before applying primer over entire surface.

G. Multiple coats:
   1. Apply minimum number of specified coats.
   2. Apply additional coats when necessary to achieve specified thicknesses.
   3. Apply coats to thicknesses specified, especially at edges and corners.
   4. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.
   5. Lightly sand and dust surfaces to receive high-gloss finishes, unless instructed otherwise by coating manufacturer.
   6. Dust coatings between coats.

H. Coat surfaces without drops, overspray, dry spray, runs, ridges, waves, holidays, laps, or brush marks.

I. Remove spatter and droppings after completion of coating.

J. Apply coating by brush, roller, trowel, or spray, unless particular method of application is required by coating manufacturer's instructions or these Specifications.

K. Plural component application: Drums shall be premixed each day. All gauges shall be in working order prior to the start of application. Ratio checks shall be completed prior to each application. A spray sample shall be sprayed on plastic sheeting to ensure set time is complete prior to each application. Hardness testing shall be performed after each application.
L. Spray application:
1. Stripe coat edges, welds, nuts, bolts, and difficult-to-reach areas by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.
2. When using spray application, apply coating to thickness not greater than that recommended in coating manufacturer's instructions for spray application.
3. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.

M. Drying and recoating:
1. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
2. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
3. Do not allow excessive drying time or exposure, which may impair bond between coats.
4. Recoat epoxies within time limits recommended by coating manufacturer.
5. When time limits are exceeded, abrasive blast clean and de-gloss clean prior to applying another coat.
6. When limitation on time between abrasive blasting and coating cannot be met before attachment of components to surfaces that cannot be abrasive blasted, coat components before attachment.
7. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
8. Touch-up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
9. Leave no holidays.
10. Sand and feather in to a smooth transition and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to the naked eye.

N. Concrete:
1. Apply first coat (primer) only when surface temperature of concrete is decreasing in order to eliminate effects of off-gassing on coating.

3.05 ALKALI-RESISTANT BITUMASTIC

A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
1. Apply in accordance with general application requirements and as follows:
   a. Apply at least 2 coats, 8 to 14 mils DFT each.
3.06  WAX COATING

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
   1. Apply in accordance with general application requirements and as follows:
      a. Apply at least 1/32-inch thick coat with 2-inch or shorter bristle brush.
      b. Thoroughly rub coating into metal surface with canvas covered wood block or canvas glove.

3.07  HIGH SOLIDS EPOXY SYSTEM

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows:
      a. Abrasive blast ferrous metal surfaces to be submerged at jobsite in accordance with SSPC SP 5 prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP 10.
      b. Abrasive blast non-submerged ferrous metal surfaces at jobsite in accordance with SSPC SP 10, prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP 6.
      c. Abrasive blast clean ductile iron surfaces at jobsite in accordance with SSPC SP 7.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply minimum 2-coat system with minimum total DFT of 12 mils.
      b. Recoat or apply succeeding epoxy coats within time limits recommended by manufacturer. Prepare surfaces for recoating in accordance with manufacturer's instructions.
      c. Coat metal to be submerged before installation when necessary, to obtain acceptable finish, and to prevent damage to other surfaces.
      d. Coat entire surface of support brackets, stem guides, pipe clips, fasteners, and other metal devices bolted to concrete.
      e. Coat surface of items to be exposed and adjacent 1 inch to be concealed when embedded in concrete or masonry.

3.08  HIGH SOLIDS EPOXY AND POLYURETHANE COATING SYSTEM

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows:
      a. Prepare concrete surfaces in accordance with general preparation requirements.
      b. Touch up shop-primed steel and miscellaneous iron.
      c. Abrasive blast ferrous metal surfaces at jobsite prior to coating. Abrasive blast clean rust and discoloration from surfaces.
      d. Degrease or solvent clean, whip abrasive blast, power tool, or hand tool clean galvanized metal surfaces.
e. Lightly sand (de-gloss) fiberglass and PVC pipe to be coated and wipe clean with dry cloths, or solvent clean in accordance with coating manufacturer’s instructions.

f. Abrasive blast clean ductile iron surfaces.

B. Application:
1. Apply coatings in accordance with general application requirements and as follows:
   a. Apply a 3-coat system consisting of:
      1) Primer: 4 to 5 mils DFT high solids epoxy.
      2) Intermediate coat: 4 to 5 mils DFT high solids epoxy.
      3) Topcoat: 2.5 to 3.5 mils DFT aliphatic or aliphatic-acrylic polyurethane topcoat.

2. Recoat or apply succeeding epoxy coats within 30 days or within time limits recommended by manufacturer, whichever is shorter. Prepare surfaces for recoating in accordance with manufacturer’s instructions.

3.09 POLYMORPHIC POLYESTER RESIN SYSTEM

A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements and as follows:
2. Prepare concrete to obtain clean, open pore with exposed aggregate in accordance with manufacturer’s instructions.
3. Prepare ferrous metal surfaces in accordance with SSPC SP 5, with coating manufacturer’s recommended anchor pattern.
4. Complete abrasive blast cleaning within 6 hours of applying prime coat. Dew point shall remain 5 degrees above dew point 8 hours after application of coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP 5.
5. When handling steel, wear gloves to prevent hand printing.
6. Adjust pH of concrete to within 5.5 to 8.0 before applying prime coat.

B. Application:
1. Apply coatings in accordance with general application requirements and as follows:
   a. Apply minimum DFT system consisting of primer, tie coat and top coat in accordance with manufacturer’s instructions as follows:
      1) Steel: 35 mils.
      2) Concrete: 45 mils.

3.10 HIGH-TEMPERATURE COATING

A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements and as follows:
   a. Abrasive blast surface in accordance with SSPC SP 10.

B. Application:
1. Apply coatings in accordance with general application requirements and as follows:
   a. Apply number of coats in accordance with manufacturer’s instructions.
3.11  ASPHALT VARNISH

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply minimum 2 coats.

3.12  COAL-TAR EPOXY SUBSTITUTE

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and in accordance with the coating manufacturer's printed instructions.

B. Application:
   1. Apply 2 coats at 6 mils to 8 mils each, for a minimum total DFT of 12 mils.

3.13  VINYL ESTER

A. Preparation:
   1. Prepare surfaces in accordance with coating manufacturer's recommendations and as directed and approved by coating manufacturer's representative.

B. Application:
   1. Apply prime coat, as required by coating manufacturer, base coat, glass mat, and topcoat to total dry film thickness of 125 mils minimum:
      a. Final topcoat on floors shall include non-skid surface, applied in accordance with manufacturer's instructions.
   2. Perform high-voltage holiday detection test in accordance with NACE SP0188, over 100 percent of coated surface areas to ensure pinhole-free finished coating system.
   3. All work shall be accomplished in strict accordance with coating manufacturer's instructions and under direction of coating manufacturer's representative.

3.14  ELASTOMERIC POLYURETHANE (100 PERCENT SOLIDS)

A. Preparation:
   1. Prepare surfaces in strict accordance with coating manufacturer's instructions and as directed and approved by coating manufacturer's representative.

B. Application:
   1. Apply epoxy primer at DFT of 1 to 2 mils, in strict accordance with manufacturer's instructions.
   2. Apply polyurethane coating at minimum total DFT as follows:
      a. Steel: 60 mils DFT.
      b. Ductile iron and ductile iron pipe coating and lining: 30 mils DFT.
      c. Concrete: 120 mils DFT.
      d. Or as recommended by the coating manufacturer and accepted by the Engineer.
3. For concrete application, provide saw cutting for coating terminations in strict accordance with manufacturer's instructions.
4. Perform high voltage holiday detection test in accordance with NACE SP0188, over 100 percent of coated surface areas to ensure pinhole free finished coating system.

3.15 CONCRETE FLOOR COATINGS

A. Preparation:
   1. Prepare surfaces in accordance with general application requirements and in strict accordance with coating manufacturer's instructions.

B. Application:
   1. Apply primer if required by coating manufacturer.
   2. Apply 1 or more coats as recommended by coating manufacturer to receive a minimum total DFT of 25 mils; color as selected by the Owner.

C. Final topcoat shall include non-skid surface, applied in strict accordance with coating manufacturer's instructions.

3.16 WATERBORNE ACRYLIC EMULSION

A. Preparation:
   1. Remove all oil, grease, dirt, and other foreign material by solvent cleaning in accordance with SSPC SP 1.
   2. Lightly sand all surfaces and wipe thoroughly with clean cotton cloths before applying coating.

B. Application:
   1. Apply 2 or more coats to obtain a minimum DFT of 5.0 mils.

3.17 FIELD QUALITY CONTROL

A. Each coat will be inspected. Strip and remove defective coats, prepare surfaces, and recoat. When approved, apply next coat.

B. Control and check DFT and integrity of coatings.

C. Measure DFT with calibrated thickness gauge.

D. DFT on ferrous-based substrates may be checked with Elcometer Type 1 Magnetic Pull-Off Gauge or PosiTector® 6000.

E. Verify coat integrity with low-voltage sponge or high-voltage spark holiday detector, for submerged service, in accordance with NACE SP0188. Allow Engineer to use detector for additional checking.

F. Check wet film thickness before coal-tar epoxy coating cures on concrete or non-ferrous metal substrates.

G. Arrange for services of coating manufacturer's field representative to provide periodic field consultation and inspection services to ensure proper surface
preparation of facilities and items to be coated, and to ensure proper application
and curing:
1. Notify Engineer 24 hours in advance of each visit by coating manufacturer's
   representative.
2. Provide Engineer with a written report by coating manufacturer's
   representative within 48 hours following each visit.

3.18 SCHEDULE OF ITEMS NOT REQUIRING COATING

A. General: Unless specified otherwise, the following items do not require coating:
   1. Items that have received final coat at factory and are not listed to receive
      coating in field.
   2. Aluminum, brass, bronze, copper, plastic (except PVC pipe), rubber, stainless
      steel, chrome, Everdur, or lead.
   3. Buried or encased piping or conduit.
   5. Galvanized steel wall framing, galvanized roof decking, galvanized electrical
      conduits, galvanized pipe trays, galvanized cable trays, and other galvanized
      items:
      a. Areas on galvanized items or parts where galvanizing has been damaged
         during handling or construction shall be repaired as follows:
         1) Clean damaged areas by SSPC SP 1, SP 2, SP 3, or SP 7 as
            required.
         2) Apply 2 coats of a galvanizing zinc compound in strict accordance
            with manufacturer's instructions.
   7. Fiberglass ducting or tanks in concealed locations.
   8. Steel to be encased in concrete or masonry.

3.19 SCHEDULE OF SURFACES TO BE COATED IN THE FIELD

A. In general, apply coatings to steel, iron, galvanized surfaces, and wood surfaces
   unless specified or otherwise indicated on the Drawings. Coat concrete surfaces
   and anodized aluminum only when specified or indicated on the Drawings. Color
   coat all piping as specified.

B. The following schedule is incomplete. Coat unlisted surfaces with same coating
   system as similar listed surfaces. Verify questionable surfaces.

C. Concrete:
   1. Vinyl ester:
      a. Secondary containment: All concrete surfaces inside chemical
         containment areas including inside wall surfaces, top of wall surfaces,
         sump area, and tank fill area, including equipment pads and tank pads.
      b. Suitable for 72 hours submerged in:
         1) 12-percent to 15-percent sodium hypochlorite.
         2) 39-percent to 47-percent ferric chloride solution.
         3) 40-percent active polymer.
      c. Concrete floor surfaces in chemical containment areas shall have a
         non-skid surface.
D. Metals:
1. Alkali-resistant bitumastic:
   a. Aluminum surfaces to be placed in contact with wood, concrete, or masonry.
2. Wax coating:
   a. Sliding faces of sluice and slide gates and threaded portions of gate stems.
3. High solids epoxy and polyurethane system: Interior and exterior non immersed ferrous metal surfaces including:
   a. Doors, doorframes, ventilators, louvers, grilles, exposed sheet metal, and flashing.
   b. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
   c. Motors and motor accessory equipment.
   d. Drive gear, drive housing, coupling housings, and miscellaneous gear drive equipment.
   e. Valve and gate operators and stands.
   f. Structural steel including galvanized structural steel.
   g. Crane and hoist rails.
   h. Exterior of tanks and other containment vessels.
   i. Mechanical equipment supports, drive units, and accessories.
   j. Pumps not submerged.
   k. Degritters, grit classifiers, frames, supports, and associated equipment.
   l. Other miscellaneous metals.
   m. Grit separation and washer, frames, supports, and associated equipment.
4. High solids epoxy system:
   a. Field priming of ferrous metal surfaces with defective shop-prime coat where no other prime coat is specified; for non-submerged service.
   b. Bell rings, underside of manhole covers and frames.
   c. Sump pumps and grit pumps, including underside of base plates and submerged suction and discharge piping.
   d. Chlorine diffuser supports.
   e. Exterior of submerged piping and valves other than stainless steel or PVC piping.
   f. Submerged pipe supports and hangers.
   g. Stem guides.
   h. Vertical shaft mixers and aerators below supports.
   i. Other submerged iron and steel metal unless specified otherwise.
   j. Interior surface of suction inlet and volute of submersible influent pumps. Apply coating prior to pump testing.
   k. Submerged piping.
   l. Exterior of influent pumps and influent pump submerged discharge piping.
5. Asphalt varnish:
   a. Underground valve boxes.

E. Fiberglass and PVC pipe surfaces:
1. Waterborne acrylic emulsion.
   a. Exterior of fiberglass ducting and fan housings.
   b. Fiberglass expose to sunlight.
   c. PVC piping exposed to view.
   d. ABS piping as determined by Engineer.

END OF SECTION
SECTION 11355A

ROTARY DRUM THICKENERS

PART 1   GENERAL

1.01 SUMMARY

A. Section includes: Rotary drum thickeners complete with auxiliary equipment, control panels, and appurtenances to thicken Waste Activated Sludge (WAS).

B. Tag Number Designations:

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>TAG NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDT Drum No. 1</td>
<td>RDT-1001</td>
</tr>
<tr>
<td>RDT Flocculator No. 1</td>
<td>MIX-1001</td>
</tr>
<tr>
<td>RDT Vendor Control Panel No. 1</td>
<td>VCP-1001</td>
</tr>
<tr>
<td>RDT Drum No. 2</td>
<td>RDT-1002</td>
</tr>
<tr>
<td>RDT Flocculator No. 2</td>
<td>MIX-1002</td>
</tr>
<tr>
<td>RDT Vendor Control Panel No. 2</td>
<td>VCP-1002</td>
</tr>
<tr>
<td>RDT Drum No. 3</td>
<td>RDT-1003</td>
</tr>
<tr>
<td>RDT Flocculator No. 3</td>
<td>MIX-1003</td>
</tr>
<tr>
<td>RDT Vendor Control Panel No. 3</td>
<td>VCP-1003</td>
</tr>
<tr>
<td>RDT Drum No. 4</td>
<td>RDT-1004</td>
</tr>
<tr>
<td>RDT Flocculator No. 4</td>
<td>MIX-1004</td>
</tr>
<tr>
<td>RDT Vendor Control Panel No. 4</td>
<td>VCP-1004</td>
</tr>
</tbody>
</table>

A. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
   a. Section 01600 - Product Requirements.
   b. Section 01610 - Project Design Criteria.
   c. Section 01612 - Seismic Design Criteria.
   e. Section 01782 - Operation and Maintenance Data.
   f. Section 05120 - Structural Steel.
   g. Section 05190 - Mechanical Anchoring and Fastening to Concrete.
h. Section 09960 - High-Performance Coatings.
i. Section 15050 - Common Work Results for Mechanical Equipment.
j. Section 15052 - Common Work Results for General Piping.
k. Section 15118 - Pressure Reducing and Pressure Relief Valves.
l. Section 15125 - Strainers and Filters.
m. Section 15958 - Mechanical Equipment Testing.
n. Section 16222 - Low Voltage Motors up to 500 Horsepower.
o. Section 16262 - Variable Frequency Drives 0.50 - 50 Horsepower.
p. Section 16412 - Low Voltage Molded Case Circuit Breakers.
q. Section 17201 - Level Measurement – Switches.
r. Section 17405 - Pressure/Vacuum Measurement – Direct.
s. Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

B. Inclusion of a specific manufacturer's name in the Specifications does not mean that the specific manufacturer's standard product will be acceptable. Specified manufacturer's or other manufacturer's standard product shall be modified as required to meet the Specifications.

C. If Contractor changes manufacturer from the equipment shown in the drawings then Contractor shall redesign building layout and modify associated piping, ducting, bridge crane, electrical, and structural support system at no expense to Owner.

D. Until all rotary drum thickeners supplied successfully complete performance testing proving conformance with the specified minimum performance requirements, 15 percent of the RDT System Price will be retained by the Owner.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1.  9 - Load Ratings and Fatigue Life for Ball Bearings.
   2.  11 - Load Ratings and Fatigue Life for Roller Bearings.

B. ASTM International (ASTM):
   1.  A36 - Specification for Structural Steel.
   8.  A500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
C. American National Standards Institute (ANSI):
      Class 25, 125, 250, and 800.

1.03 SYSTEM DESCRIPTION

A. General:
   1. Provide four rotary drum thickening units, complete with: floc development
      tanks, driven impellers, rotary drums with filtration media, supporting frames,
      spray deflection coverings, spray wash headers, return water collection tanks,
      hoppers, sludge conditioning systems, control panels, and auxiliary equipment
      and appurtenances.
   2. Provide rotary drum thickening units:
      a. Designed for continuous operation.
      b. Capable of performing in accordance with the requirements set forth in
         these Specifications.
      c. Modified from standard equipment to meet all requirements in this
         Specification.
   3. Provide equipment in accordance with Section 15050.

B. System Description:
   1. Thickening Process: The sludge, mixed with an emulsion polymer, will enter
      the floc development tank where a low-shear, adjustable speed mixer will
      promote flocculation. The flocculated solids and liquid will flow into the rotary
      drum screen through a step-down header or distribution tray. In the rotary
      drum screen, the liquid will separate from the flocculated solids through the
      woven wire mesh or wedge-wire, be collected in the return water tank, and exit
      through a drain located as indicated on the Drawings. At a minimum, radial
      flights inside the drum shall be provided to direct sludge as it is thickened
      towards the discharge end of the drum. Mounted above the rotary drum screen
      will be a self-cleaning wash water spray header. This spray header will keep
      the rotary drum screen openings clear of solids.
   2. Sludge Characteristics: Sludge characteristics to be fed to the rotary drum
      thickeners are as follows:
      a. Type of Feed Sludge:
         1) Unthickened Waste Activated Sludge (UWAS) from secondary
            clarifiers.
      b. Feed Solids, Percent Total Suspended Solids: 0.7 to 1.0.
      c. Feed Volatile Solids Content, Percent: 60 to 80.
      d. Feed pH Range: 5.5 to 8.0.
      e. Feed Maximum Solids Size, Inches: 1.

C. Minimum Performance Requirements:
   1. As a minimum, each rotary drum thickener shall be capable of operating at the
      following conditions for the specified feed sludge characteristics:
      a. Maximum Hydraulic Feed Rate: 400 gpm.
      b. Minimum Hydraulic Feed Rate: 200 gpm.
      c. Solids Feed Rate at Maximum Hydraulic Feed Rate: 2,000 lbs/hr at
         1.0-percent total suspended solids (dry weight basis) or 1,400 lbs/hr at
         0.7-percent total suspended solids (dry weight basis).
d. Solids Feed Rate at Minimum Hydraulic Feed Rate: 1,000 lbs/hr at 1.0-percent total suspended solids (dry weight basis) or 700 lbs/hr at 0.7-percent total suspended solids (dry weight basis).

e. Maximum Active Polymer Dosage: Maximum 15 active lbs polymer/ton feed solids (dry basis, 100-percent active polymer).
   1) Polymer will be manufactured by Solenis, SNF Polydyne, BASF/Ciba/Allied Colloid, or Ashland/Stockhausen. No other manufacturers or third-party suppliers are acceptable to the Owner.

f. Minimum Solids Capture: 95 percent.

g. Thickened Sludge Solids Concentration: 5.5 percent minimum on a dry-weight basis at the specified hydraulic and solids loading rates.

1.04 SUBMITTALS

A. The manufacturer shall submit product data and shop drawings including operation and maintenance manuals to the Engineer for review in accordance with Section 01782 and Section 15050.

B. The Contractor shall coordinate and provide simultaneous submittal of the shop drawings for the rotary drum thickeners, rotary drum thickener support system, mezzanine structure including platforms for the flocculation tanks and hoppers, and piping system associated with the rotary drum thickeners and Thickened Waste Activated Sludge (TWAS) pumps.

C. Shop Drawings: The following shall be submitted in compliance with Section 15050:
   1. Make, model, and weight of each equipment assembly.
   2. Complete catalog information, descriptive literature, specifications, and materials of construction.
   3. Detailed structural and mechanical drawings showing the equipment dimensions, size, and installation.
   4. Detailed structural and mechanical drawings showing motors, thickener drives, schematic wiring diagrams and interconnections wiring diagrams, interconnecting piping, pipe supports, control panel layouts, and size and length of each support frame member.
   5. Factory protective coatings.
   6. Anchor bolt calculations and mounting details for each equipment assembly as required by Sections 01612 and 15050.
   7. Electrical information including, but not limited to, full load current and locked rotor current.
   8. All submittal information as required per Division 16 and 17 Sections.
   9. Weight and dimensions for vendor-supplied control panels.
   10. Details of storage and off-loading requirements.
   11. Sample warranty.

D. Quality Control Submittals:
   1. Factory functional test report.
   2. Field performance test report.
   3. Certified test results for sludge conditioning system.
   5. Manufacturer's installation manuals.
E. Maintenance Manual: Submit the following:
   1. Lubrication instructions.
   3. Operation instructions.
   4. Start-up instructions.
   5. Unloading and handling methods.

F. Manufacturer's Qualifications: Submit all information proving conformance with
   manufacturer's qualifications requirements.

G. Warranties.

H. Certificates.

I. Technician Qualifications Resume: Submit resume of technician to perform rotary
   drum thickener adjustments, inspections, performance testing, and training.

J. Training Course Outline.

1.05 QUALITY ASSURANCE AND CONSIDERATION OF ALTERNATIVES

A. Manufacturer Qualifications:
   1. Manufacturer must have at least 10 years' experience in the design,
      application, and supply of rotary drum thickeners of the type described in this
      Specification for the municipal wastewater sludge thickening market. Manufacturer
      shall provide a signed affidavit stating conformance with these requirements.
   2. Manufacturer must provide references for at least 10 installations at municipal
      wastewater treatment plants in the United States, which have been in
      operation for at least 5 years, with the same capacity and design as the rotary
      drum thickeners to be provided under this contract.
      a. Reference information shall include treatment plant name and location,
         contact name for personnel at treatment plant, contact telephone number,
         date of installation, model number of unit installed, number of units
         installed, and type of sludge being treated.
      b. Installations:
         1) Each installation shall meet all of the following criteria for thickening
            sludge at municipal wastewater treatment plants in the United States:
            a) Rated Hydraulic Feed Rate: 400 gallons per minute (gpm).
            b) Rated Solids Feed Rate: 1,400 lb/hr at 0.7 percent total
               suspended solids (dry weight basis).
            c) Maximum Active Polymer Dosage to Achieve Required
               Performance: 15 active lbs/dry ton of feed solids (maximum).
            d) Minimum Solids Capture: 95 percent.
            e) Minimum Thickened Sludge Solids Concentration: 5-percent
               minimum (dry weight basis).

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide delivery, storage, handling, and any required periodic maintenance from
   delivery until start-up in accordance with manufacturer's recommendations,
   Section 01600, and Section 15050.
B. The rotary drum thickener system, including all principal system elements, is to be fully assembled and mounted on a single structural steel skid for simplified movement and installation.

1.07 PROJECT CONDITIONS

A. Environmental Requirements: As specified in Section 01610.

1.08 SEQUENCING AND SCHEDULING

A. Coordinate work with restrictions as specified in General Conditions.

1.09 WARRANTY

A. Provide a Manufacturer's warranty meeting the requirement of General Conditions.

1.10 MAINTENANCE

A. As specified in Section 15050.

B. If special tools are required for the service and maintenance of the unit, provide one complete set of tools.

C. The following spare parts will be provided:
   1. One set of trunnion wheels per rotary drum thickener.
   2. One driven sprocket per rotary drum thickener.
   3. One drive sprocket per rotary drum thickener.
   4. One idler sprocket per rotary drum thickener.
   5. One drive chain per rotary drum thickener.
   6. One spare drum drive, including all associated couplings, gear reducers, and other components required for a fully functioning drive.
   7. One spare flocculation tank mixer drive, including all associated couplings, gear reducers, and other components required for a fully functioning drive.

D. Contractor, inspector, and Owner’s maintenance representative shall inventory and account for all tools and spare parts delivered to the site. Each party will sign a turnover agreement. Owner will then take possession and responsibility for items.

E. Provide a 5 year maintenance agreement to include regular service interval maintenance and replacement of all wear parts at the end of the 5 year period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal approved by Owner based on Owner's review of manufacturer's proposal:
   1. Parkson Corporation, Hycor Thicktech Model RDT 400 (Basis of Design).
   2. Andritz, PDR Series.
   3. Vulcan.
   4. FKC.
   5. Alfa Laval.
2.02 IDENTIFICATION

A. Identify each unit of equipment with a corrosion-resistant nameplate, securely affixed in a conspicuous place. Nameplate information shall include equipment model number, serial number, manufacturer's name and location, and any data required by manufacturer for ordering replacements.

B. Provide in accordance with Section 15050.

2.03 MATERIALS

A. System Components:
   1. Skid: Fabricated of Type 316L stainless steel.
   2. Frame: Fabricated from ASTM A276 Type 316 stainless steel.
   4. Input Connection: ASTM A240, Type 316 stainless steel.
   6. Discharge Assembly: ASTM A240, Type 316 stainless steel.
   7. Driven Impeller and Shaft: ASTM A240, Type 316 stainless steel.
   8. Rotary Element Composed of Input Assembly: ASTM A240, Type 316 stainless steel.
   9. All Internal Drum Components, including flights, roll bars, split augers, and detention ports: ASTM A240, Type 316 stainless steel.
   17. Internal Piping: Schedule 80 polyvinyl chloride.
   18. Anchor Bolts and Miscellaneous Hardware, Including Bolts, Nuts, Washers, and Fastener Clips: ASTM A320, Type 316 stainless steel.
   20. Materials in Contact with Polyelectrolyte or Sludge: ASTM A240, Type 316 stainless steel, unless otherwise specified.
   21. Piping and Valve Connections: Flanged or grooved-end pipe for metallic pipe, and solvent-welded socket type for polyvinyl chloride.

B. Requirements for System Stainless Steel:
   1. Stainless steel and associated fabrications shall meet the requirements of Section 05120.
      a. Fabricate and install in accordance with the best practices of the trade.
   2. Cleaning and passivation:
      a. Following shop fabrication of stainless steel members, clean and passivate fabrications.
      b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a passive finished surface.
c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
   1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.

d. Pre-clean, chemically descale (pickle), and final clean fabrications in accordance with the requirements of ASTM A380 to remove deposited contaminants before shipping.
   1) Passivation by citric acid treatment is not allowed.
      a) If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible; however, these treatments shall be followed by inorganic cleaners such as nitric-hydrofluoric acid.
   2) Provide acid descaling (pickling) in accordance with Table A1.1 of Annex A1 of ASTM A380.
   3) After pickling, final cleaning of stainless steel shall conform to Part II of Table A2.1 of Annex A2 of ASTM A380.

e. After cleaning, inspect using methods specified for "gross inspection" in ASTM A380.

f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the job site.

2.04 EQUIPMENT

A. Equipment Skid Base:
   1. All thickening equipment shall be provided on a single equipment skid designed to accommodate all operating and static loads without deflection, deformation, or vibration, which will in any manner degrade performance of the equipment. At a minimum, the flocculation tank, drum, frame, and covers must all be mounted on a single skid designed for even distribution of all loads. Lifting lugs shall be provided, allowing for movement of entire assembled unit.
   2. The skid shall be fabricated of welded and bolted Type 316L stainless steel members. The skid shall be capable of spanning between two concrete pier supports as shown on the Drawings.

B. Floc Development System:
   1. The flocculation tank shall be equipped with a 6-inch flanged pipe stub inlet near the bottom of the tank and an outlet to a discharge flume assembly or distribution box.
   2. The driven impeller of the flocculation system shall be composed of a shaft and a double vertical flat blade on either side of the shaft with a nylon steady bearing centrally located on the bottom of the tank.
   3. Flocculation tank shall be connected to the thickening section in such a way that foul air will flow with the sludge to the hopper for removal.
   4. Flocculation tank shall have a stainless steel cover with a hinged opening that is easily opened for inspection of the flocculation process.

C. Rotary System:
   1. The rotary system shall be composed of filter screen on the drum support structure that rotates horizontally around a center feed assembly. The filter screen shall consist of stainless-steel woven-wire mesh or wedge wire selected on the basis of porosity or percent openness, the opening size, and
the wire diameter used in the weaving process. The wire mesh or wedge wire selections shall be made on the basis of maximizing flow consistent with the requirements for high-quality filtrate.

a. Filter Screen Minimum Percent Open Area: 25 percent.

2. The woven-wire mesh or wedge wire filter screen shall be easily changed from the drum support structure with simple tools.

3. The rotary system shall be equipped with flights and/or roll bars, split augers, ports, closures, and deflectors to influence shear, water release, and drainage rate independent of flow.

4. The rotary system drive shall be fitted with a zero-motion detector. If movement of the rotary system is not sensed, the zero-motion detector shall relay an alarm. The zero-motion detector shall be calibrated to operate between the minimum and maximum recommended speeds for the rotary system.

D. Drum Wash System shall be designed to boost or reduce pressure if necessary and provide a continuous flow of plant service non-potable water (NPW) to the spray header designed to keep the thickening drum orifices clear of solids:

1. Water Supply System:
   a. Pressure Reducing Valve:
      1) If necessary, design and supply for Contractor-installation, a pressure reducing valve and 40 mesh strainer system for each rotary drum thickener.
      2) Pressure reducing valve shall be in compliance with Section 15118. Pressure reducing valve shall be capable of reducing maximum plant service NPW pressure to required pressure.
      3) Strainer shall be oversized to accommodate the flow equivalent to twice the normally required wash water flow. Strainer shall be easy to remove for inspection and maintenance cleaning. Strainer shall be in compliance with Section 15125.

   b. Wash water has the following characteristics:
      1) Washwater: Plant service non-potable water is available at a reliable minimum pressure of 100 psig, although it can fluctuate to a maximum pressure of 120 psig.
      2) Solids Content: Up to 50 milligrams per liter (mg/L) of suspended solids.
      3) Chlorine Residual: Up to 3 mg/L of total chlorine residual.

2. Spray Header:
   a. A self-cleaning washing header shall be oriented in a horizontal position the length of the rotary system to maintain positive cleaning with each revolution of the rotary system, forcing the washed off solids to return to the mass of solids tumbling inside the rotary element. The washing header shall be mounted with U-bolts permitting the adjustment of the angle of impact of the water, from tangential to square, relative to the rotary system.

   b. Manufacturers: One of the following or equal:
      1) Appleton Manufacturing, Menasha Corp., Menasha, WI.
      2) Heinrich Stamm Co. Worms AMRhein, Germany.
      3) Sprayco, Nashua, NH.
c. Provide a 2-inch 2-way solenoid valve to be connected just upstream of the wash water connection to the spray water header. The solenoid valve shall comply with requirements below:
   1) Manufacturers: One of the following or Engineer approved equal:
      a) Automatic Switch Company, Series 8210.
      b) Skinner Electric Valve Division, Series C.
   2) Design:
      a) Valves: Suitable for service under the following conditions:
      b) Fluid: As indicated on the Pipe Schedule.
      c) Temperature of fluid: 60-70 degrees Fahrenheit.
      d) Piping test pressure: As indicated on the Pipe Schedule pounds per square inch gauge.
   3) Unless otherwise indicated on the Drawings, provide valves that have:
      a) Minimum NEMA Type 4 enclosure.
      b) 120 VAC operation.
      c) Suitable for use as indicated on the Drawings.
      d) Minimum Class F coil insulation.
   4) 2-way valves: Furnish with openings of size equal to or larger than the nominal size designation of the valve.
   5) Furnish with manual/bypass operators.
   6) The valve shall be shipped loose to prevent damage.

d. Nozzles: Replaceable, designed with a built in hand wheel operated stainless steel brush to provide cleaning action without disassembly; handwheel to extend to outside of thickener so brush can be operated without interruption of the thickener operation.

e. Nozzle spacing shall be such that the sprays from adjacent nozzles overlap one another at the drum surface.

f. Spray header shall be fitted with an Ashcroft stainless steel pressure gauge, liquid filled type 1008S with a 1/4 inch NPT back connection, 2-1/2 inches dial dual scaled at 0/160 psi.

g. Washing system shall include an adjustable flow or pressure switch that shall relay an alarm if the solenoid valve on the spray water system fails and wash water can no longer be supplied to the washing header.

h. Spray piping and nozzles: Braced and of sufficient pressure rating to withstand pressure caused by sudden valve closure.

E. Shower Deflection:
   1. The rotary element shall be covered on the outside with shower deflection covers designed to contain any fugitive spray and minimize mist emissions. The panels shall overlap and shall be fastened to the framing members of the rotary element. The panels shall be limited in dimension and fastened to the framing members by wing nuts to facilitate removal.

F. Return Water/Filtrate Collection:
   1. All elements of the rotary system and supporting frame shall be contained and mounted over the return water or filtrate water collection tank. Delivery of collected filtrate water shall be by gravity through one filtrate tank drain, which shall be an 8-inch flanged pipe stub. The pipe stub shall discharge in the direction indicated on the Drawings.
   2. Provide a 1-inch flanged stub on the bottom of the filtrate drain pipe connection for sampling purposes as indicated on the Drawings.
G. TWAS Discharge Hopper:
1. Rotary drum thickener manufacturer shall provide one fully removable TWAS hopper for each rotary drum thickener.
   a. Provide the thickened sludge hopper to convey thickened sludge from the rotary drum thickener discharge to the TWAS pump suction as shown in the Drawings.
   b. The structural design of the hopper, its connections to the rotary drum thickener, and its supports shall be designed in accordance with the requirements for structural steel in Section 05120 and the load combinations provided herein.
   c. The hopper shall be supported off of the platform steel framing shown on the plans. Under no circumstances shall the weight of the hopper and its contents be transferred to the pump below.
   d. Hopper shall consist of two sections that are bolted together such that top portion of the hopper can be disconnected from the bottom portion of the hopper and the drum, and removed while the bottom portion remains in place and supported from the platform steel framing. Design of the hopper and thickener skid shall allow removal of the thickener skid over the bottom portion of the hopper once the top portion of the hopper is removed and skid is elevated a maximum of 6 inches.
      1) Manufacturer shall provide a Type 316 stainless steel plate with lifting eyes sized to cover the opening of bottom portion of the hopper upon removal of the top portion. Manufacturer shall provide support brackets in bottom portion of hopper upon which plate shall rest.
   e. Lateral design shall be in accordance with Seismic Design Criteria specified in Section 01612 and with the specified load combinations.
   f. Load Combinations: Design each structural member for the most critical load combination resulting from the following load combinations:
      1) Dead Load + Live Load (contents under extreme service conditions).
      2) Dead Load + Live Load (contents under normal service conditions) + Seismic Load.
      3) Components shall be designed for additional load combinations per ASCE 7-05.
   g. Construct the hopper of Type 316 stainless-steel plates welded and braced as required for rigidity. Stainless-steel plates shall conform to the requirements of Section 05120.
   h. The hopper shall be fitted with doors to allow easy access for thickened sludge inspection and sampling.
   i. Provide each portion (top and bottom) of the thickened sludge hopper with two 3-inch diameter welded lifting rings fabricated from 1/2-inch thick (minimum) stainless-steel bars.
   j. All materials used for fabrication shall conform to the structural and miscellaneous standards of the American Institute of Steel Construction.
   k. Provide hopper with both the interior and exterior surfaces of the hopper smooth, free from sharp edges, burrs, and projections, and with all welds ground smooth and all edges and corners rounded.

2. Hopper Requirements:
   a. The hopper shall have a minimum volume of 540 gallons and shall extend down as a rectangular chute to a flanged rectangular flexible coupling that will be connected to the TWAS pump suction flange.
      1) Rectangular Flexible Coupling: Rotary drum thickener manufacturer to provide flanged rectangular flexible coupling with Neoprene rubber
and Type 316 stainless steel hardware manufactured by Mercer-Rubber Co. or equal.

a) Materials of construction for rectangular flexible coupling shall be suitable for conditions experienced in this service.

2) Sludge Hopper Bottom Flange: Coordinate with rectangular flexible coupling manufacturer and pump manufacturer as specified in Section 11312R.

b. The minimum incline angle of the sloped section of the hopper is 50 degrees from the horizontal.

c. Do not allow any part of the hopper to come in contact with the rotary drum thickener drives or to interfere with the normal operation of the unit.

d. Provide a 4-inch diameter flanged connection on rectangular chute as shown on the Drawings for draining the hopper to the filtrate sump when the TWAS pump is not operating.

3. Hydrostatic level sensor and transmitter as specified in Section 17405 shall be provided by the Contractor for installation and level measurement in the sludge hopper.

a. Thickener manufacturer shall provide a 4-inch diameter flanged connection on rectangular chute as shown on the Drawings for mounting of the hydrostatic level sensor.

4. Float level switch for high-high level condition in sludge hopper shall be provided by the Contractor as specified in Section 17201.

a. Thickener manufacturer shall provide a Type 316 stainless steel bracket to accommodate float level switch mounting.

5. Thickener manufacturer shall provide flanged Type 316 stainless steel 6-inch odor control nozzle on hopper to allow withdrawal of foul air from entire thickener, including flocculation tank. Manufacturer shall provide Type 316 stainless steel support brackets for 6-inch foul air duct along outside of hopper as indicated on the Drawings. Locations on hopper where odor control nozzle and support brackets are located shall be reinforced.

H. In-Line Non-Clog Venturi Mixing Valve, Polymer Injection Ring, and Manifold (Sludge Conditioning System):

1. Each rotary drum thickener shall be provided with a sludge conditioning system designed to efficiently mix polymer with the sludge and to adequately condition the sludge for optimum thickening. Each sludge conditioning system shall include an in-line non-clog venturi mixing valve, polymer injection ring, and manifold that shall be supplied by the rotary drum thickener manufacturer and installed by the Contractor.

2. The sludge conditioning system shall be mounted upstream of the thickener and shall consist of an in-line venturi mixer with a variable orifice, polymer injection ring, and polymer solution distribution manifold. The rotary drum thickener manufacturer shall be required to provide to the Engineer a proper layout for the system.

3. Flocculation time shall be adjustable by the displacement of grooved pipe sections (spools) with the sludge conditioning system at a minimum of three locations in the sludge feed piping. The sludge conditioning system supplied by the rotary drum thickener manufacturer will be installed at one of the three locations. Pipe spools of proper size shall be supplied by the Contractor and will occupy the remaining two locations.
4. The sludge conditioning system shall meet the following mechanical specifications:
   a. In-Line Venturi Mixer:
      1) The in-line mixer shall have a flanged Type 316 stainless-steel housing, an adjustable orifice connected to an externally mounted lever and counterweight, and a removable side plate for inspection and cleaning. Flanges shall be ASME/ANSI B16.1 Class 125 flanges.
      2) The open throat area shall be approximately 4.50 square inches or greater, as required for specified hydraulic capacity, fully adjustable downward, and shall open automatically to prevent clogging.
      3) The position of the counterweight on the externally mounted orifice plate lever shall be fully adjustable, within a 180-degree arc, to allow for adjustment of the mixing energy, regardless of the mounting angle, while the unit is in operation.
   b. Polymer Injection Ring:
      1) The injection ring shall have four injection points evenly distributed 90 degrees apart along its circumference for injecting polymer into the sludge flow.
   c. Manifold Block:
      1) The manifold distribution block shall divide the single polymer solution feed line into four separate flows for connection to the polymer injection ring.
   d. Performance Requirements:
      1) Polymer solution and sludge mixed in less than 1.0 second at rated hydraulic capacity.
      2) Mixing energy independently adjustable during operation.

5. Sludge Conditioning System Testing:
   a. Each sludge conditioning system shall be hydrostatically tested by the manufacturer at the factory. Certified test results indicating that each system has passed the specified test parameters shall be submitted for approval. No sludge conditioning system shall be shipped or installed until this testing has been completed and test results have been approved by the Engineer.
   b. Each system shall be tested as specified below:
      1) The testing medium shall be water. Under no circumstances is air to be used as the test medium.
      2) Each system shall be tested at the test pressure specified in Section 15052 for the sludge feed piping.
      3) The test duration shall be 5 minutes. A passing test is one where there is no visible leakage and no decrease on the initial test pressure.
   c. A sludge conditioning system that fails the pressure test shall be either repaired or replaced at no additional cost to the Owner. Repaired systems shall be retested. Replacement systems shall be tested using this procedure.

I. Drive Units:
   1. The following drive units shall be supplied for each rotary drum thickener:
      a. Main Unit Drum Drive:
         1) 5-horsepower (maximum), 1,800 revolutions per minute, TEFC, 460-volt, 3-phase, 60-Hertz alternating current, premium
high-efficiency motor with 1.0 service factor and conforming to Section 16222.

2) The controller shall be a variable frequency drive (VFD) mounted in the rotary drum thickener vendor control panel and shall comply with Sections 16262.

b. Floc Tank Drive:
   1) 1.0-horsepower (maximum), 1,800 revolutions per minute, TEFC, 460-volt, 3-phase, 60-Hertz alternating current, premium high-efficiency motor with 1.0 service factor and conforming to Section 16222.
   2) The controller shall be a VFD mounted in the rotary drum thickener vendor-control panel and shall comply with Sections 16262.

c. NPW Booster Pump Drive (if required), floor mounted separately:
   1) 5 horsepower (maximum), 1,800 revolutions per minute, TEFC, 460 volt, three phase, 60 hertz alternating current, premium high efficiency motor with 1.15 service factor and conforming to Section 16222.

2. Mounting: Anchored rigidly to the rotary drum thickener system frame.

3. All motor shall be provided with temperature switches and motor winding heaters as specified in Section 16222.

J. Vendor Control Panel (VCP) and Controls:
   1. The VCP shall be powered from a 460-volt, 20 amp, 3-phase 60 hertz power supply.
      a. Rated to withstand the available fault current of 65kA.
   2. The RDTs shall be controlled as follows:
      a. When the HAND/OFF/AUTO selector switch at the RDT LCP is in HAND, the drum drive, flocculator drive, NPW booster pump and spray water solenoid valve can be controlled by the individual START/STOP and OPEN/CLOSE pushbuttons for each component. The drum and flocculator drive speeds can be controlled with their respective potentiometers.
      b. Upon activation of any EMERGENCY STOP cord, all components of the RDT shall stop and close.
      c. When the HAND/OFF/AUTO selector switch is in AUTO, the RDT shall be controlled by the plant PLC.

3. Components:
   a. Remote monitoring and control:
      1) Provide dry relay contact outputs for the following:
         a) System Auto.
         b) System Failed.
         c) Emergency Stop.
         d) System Running.
         e) Flocculator Failed.
         f) Flocculator Running.
         g) Drum Running.
         h) Drum Failed.
         i) Low Spray Water Pressure or Flow.
         j) Zero-motion.
      2) Accept 120VAC discrete inputs for the following:
         a) Flocculator Run.
         b) Drum Run.
3) Provide 4-20mA outputs for the following:
   a) Flocculator Speed.
   b) Drum Speed.
4) Accept 4-20mA inputs for the following:
   a) Flocculator Speed Setpoint.
   b) Drum Speed Setpoint.

b. Circuit Breakers:
   1) In accordance with Section 16412.

c. Enclosure and associated components:
   1) In accordance with Section 17710.
   2) NEMA Type 12 enclosure.
   3) Provide flange-mounted disconnect handle:
      a) Door-mounted disconnect handles are not acceptable.
4) Provide control power transformer rated for the applicable loads.

d. Install each RDT with a safety shutoff switch complete with mounting
   brackets, eye bolts, and pull cord extending along the entire length of the
   RDT. Install dual systems accessible from both sides. Mount cord
   supported by eye bolts on approximate 10 feet centers. The switch shall
   be provided with two single pole double throw micro-switches with
   external signal light. The switch shall be provided in a NEMA 4 aluminum
   housing with an epoxy coating. The actuating arm shall be a red epoxy
   coated steel handle with stainless steel shaft. The switch shall be rated for
   120 volts AC. The switch once tripped shall require manual reset.

2.05 FINISHES

A. Coating shall comply with requirements for high solids epoxy and polyurethane
   coatings in Section 09960.

B. Coat metal surfaces, other than stainless steel, with coating system consisting of
   2-part epoxy primer, 2 coats of high solids epoxy, and 1 coat of polyurethane top
   coat with minimum total dry film thickness of 12 mils.

PART 3 EXECUTION

3.01 INSTALLATION

A. The rotary drum thickeners, associated equipment, and appurtenances shall be
   installed under the direction of the system supplier in strict conformance with the
   manufacturer's installation instructions and with favorable review of shop drawings.

B. Alignment of piping may vary from that indicated on the Drawings to suit the
   equipment furnished, without additional cost to the Owner.

C. Connect electrical power, hydraulic or pneumatic tubing, water piping, polymer
   solution piping, and sludge piping.

3.02 EXAMINATION

A. As specified in Section 15050.
3.03 FIELD COATING

A. Field coat as specified in Section 09960.

3.04 FIELD QUALITY CONTROL

A. Process Optimization:
   1. A sludge evaluation shall be performed by the manufacturer. Three weeks prior to optimization process, the Owner will send to the manufacturer a healthy, representative feed sludge sample. The feed sludge sample shall consist of UWAS from secondary clarifiers. The manufacturer shall perform optimization tests for the polymer and inform the Contractor of the polymer selected for optimization.
      a. The Contractor shall notify the Owner 2 weeks prior to the required sludge sample shipping date.
   2. Manufacturer to optimize process including, but not limited to, polymer dosage, location of polymer injection, unit drive speed, and floc drive speed.
   3. Optimization of process shall be completed 3 weeks prior to start-up.
   4. Contractor shall supply one 300-gallon (nominal) polymer tote of the selected polymer required for optimization.

B. Functional Tests:
   1. Functional testing of the entire rotary drum thickening system is to be conducted following inspection, installation, and cleaning of the rotary drum thickeners.
   2. Perform functional testing as specified in Sections 01756 and 15958.
   3. Testing to be conducted by the Contractor and the manufacturer's representatives in the presence of the Engineer to demonstrate that equipment is capable of performing its specified function in a satisfactory manner without mechanical or electrical defects, binding, or operational difficulties.
   4. Performance Test:
      a. Conduct performance tests for each rotary drum thickener comprising the thickener system to verify that each unit meets the minimum performance requirements specified herein.
         1) Performance testing to prove conformance with minimum performance requirements shall be conducted on UWAS feed.
         2) Performance testing shall be conducted for one thickener at a time.
      b. Performance test for each rotary drum thickener shall be 2 consecutive days in duration, 8 hours of operation one day and 8 hours of operation the second day.
      c. Provide written test procedures including sampling frequency and analysis at least 30 days prior to start of testing. Manufacturer shall recommend optimal polymer and required polymer concentration.
      d. Contractor shall provide recommended polymer; Owner will provide non-potable water, power, sludge feed, and thickened sludge pumping. Equipment and systems installed under this project may be used by the manufacturer during the performance test.
      e. The manufacturer shall operate the equipment throughout the duration of the test, obtain the samples in the presence of the Owner, and document the data needed to confirm the performance of the thickener unit. Contractor shall immediately transfer samples to the Owner and the Owner will conduct the laboratory tests.
f. One sample of the following flow streams shall be obtained for each hour of operation during the performance test:
1) Feed sludge.
2) Filtrate.
3) Thickened sludge.
4) Polymer solution.

g. The following process data shall be recorded and documented each half hour of the test:
1) UWAS feed sludge flow rate, solids concentration, and mass rate.
2) Polymer dosage and feed rate.
3) Cumulative thickened sludge flow.
4) Alarm conditions.
5) Equipment problems.
6) Drum drive speed.
7) Floc drive speed.

h. Performance Test Results:
1) Laboratory test results prepared by Owner will be transmitted to manufacturer for evaluation to determine acceptability of performance.
2) Average values for thickened sludge concentration, polymer consumption, and percent capture over the 16-hour test period shall be determined for each separate rotary drum thickener.
3) The performance of each rotary drum thickener will be deemed acceptable if the average values for each operating parameter meet or exceed the specified minimum value with an upper confidence limit of 95 percent.
4) In the case of unacceptable performance, the manufacturer shall have 30 days to make equipment modifications, implement physical or operational changes, make adjustments to the equipment, and conduct supplemental tests.

i. In the case of unacceptable performance, the manufacturer shall then have 30 days in which to perform, at its sole expense, any supplemental testing, equipment adjustments, changes, or additions and request an additional retest of the unacceptable system. If the modified equipment then does not meet the minimum performance requirements of this Specification, a payment retention shall be imposed as damages.

j. Until all rotary drum thickeners supplied successfully complete performance testing, 15 percent of the System Price will be retained by the Owner.

5. Excessive vibration or noise shall be corrected, as specified in Section 15050.
6. Verify that all connections, including connections for sludge conditioning system, are watertight.
7. During testing, Contractor shall make all final adjustments necessary to place equipment in satisfactory working order.
8. Test and calibrate all controls, switches, automatic valves, and other instrumentation and control equipment associated with the rotary drum thickening system specified herein, in accordance with the manufacturer's printed instruction over the full operating range of the equipment.
9. Provide certified test report as specified in Section 01756.
10. Coordinate testing with functional testing of other related equipment.
3.05 MANUFACTURER'S FIELD SERVICES

A. Coordinate field service work with the Manufacturer's Representative, Owner, and Engineer prior to initiating such work.

B. Contractor shall furnish a qualified Manufacturer's Representative to provide manufacturer's field services as specified in Section 01756.

C. Require Manufacturer's Representative to perform the following services as described below and as specified in Section 01756. The specified durations are the minimum required time on the jobsite. Additional services and/or longer durations shall be provided as needed at no cost to Owner to meet the required quality of work.

1. Installation Assistance: As required.
2. Installation Inspection: 2 Workdays.
5. Training per Section 01756 and as further described below: 16 hours.
   a. Operations Training: 8 hours.
   b. Mechanical Maintenance Training: 4 hours.
   c. Electrical Maintenance Training: 4 hours.
7. Post Start-up Field Visit: 1 Workday.

D. Additional Training Requirements:

1. The manufacturer shall submit a course outline plan three months before training starts, with proposed class material and class schedule to the Owner for approval. Training will begin only if the class material and class schedule have been reviewed and approved by the Owner.
2. Training will begin only after at least one rotary drum thickener has successfully passed all required functional and performance tests.
3. Subjects of instruction shall include the following:
   1) Start-up procedures.
   2) Shutdown procedures.
   3) Troubleshooting.
   4) Selection of proper polymer types and dosages.
   5) Operating adjustments for performance optimization.
   6) Preventative maintenance.
   7) Removal and replacement of rotary drum thickener components.
   8) Maintenance procedures.
   9) Emergency procedures.
   10) Record keeping.
   11) Mechanical unit function and description.
   12) Variable frequency drives.
   13) System controls.

END OF SECTION
SECTION 15050
COMMON WORK RESULTS FOR MECHANICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic design and performance requirements for mechanical equipment.

B. Related sections:
   1. Section 01600 - Product Requirements.
   2. Section 01610 - Project Design Criteria.
   3. Section 01612 - Seismic Design Criteria.
   5. Section 01782 - Operating and Maintenance Data.
   6. Section 05120 - Structural Steel.
   7. Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
   8. Section 09960 - High-Performance Coatings.
   9. Section 15052 - Common Work Results for General Piping.

1.02 REFERENCES

A. American Gear Manufacturer’s Association (AGMA) Standards:
   1. 6001-E08 - Design and Selection of Components for Enclosed Gear Drives.

B. American Bearing Manufacturers Association (ABMA) Standards:
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. American Petroleum Institute (API):
   1. 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps.

D. ASTM International (ASTM):
   5. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   6. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
11. B62 - Standard specification for Composition Bronze or Ounce Metal Castings.

E. Food and Drug Administration (FDA).
F. International Concrete Repair Institute (ICRI):
   1. 310.2R - Selecting and specifying Concrete surface preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

G. Hydraulic Institute (HI).
H. NSF International (NSF).

1.03 DEFINITIONS

A. Special tools: Tools that have been specifically made for use on unit of equipment for assembly, disassembly, repair, or maintenance.

B. Resonant frequency: That frequency at which a small driving force produces an ever-larger vibration if no dampening exists.

C. Rotational frequency: The revolutions per unit of time usually expressed as revolutions per minute.

D. Critical frequency: Same as resonant frequency for the rotating elements or the installed machine and base.

E. Peak vibration velocity: The root mean square average of the peak velocity of the vibrational movement times the square root of 2 in inches per second.

F. Rotational speed: Same as rotational frequency.

G. Maximum excitation frequency: The excitation frequency with the highest vibration velocity of several excitation frequencies that are a function of the design of a particular machine.

H. Critical speed: Same as critical frequency.

I. Free field noise level: Noise measured without any reflective surfaces (an idealized situation); sound pressure levels at 3 feet from the source unless specified otherwise.
J. Operating weight: The weight of unit plus weight of fluids or solids normally contained in unit during operation.

1.04 SYSTEM DESCRIPTION

A. General:
1. Product requirements as specified in Section 01600.
2. Materials in contact with drinking water as specified in Section 01600.
3. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions as specified in this Section.
4. Provide equipment and parts that are suitable for stresses, which may occur during fabrication, transportation, erection, and operation.
5. Provide equipment that has not been in service prior to delivery, except as required by tests.
6. Like parts of duplicate units are to be interchangeable.
7. When 2 or more units of equipment for the same purpose are required, provide products of same manufacturer.
8. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries required for proper operation.
9. When necessary, modify manufacturer's standard product to conform to specified requirements or requirements indicated on the Drawings and contained in Laws and Regulations.

B. Material requirements:
1. Materials: Suitable for superior corrosion resistance and for services under conditions normally encountered in similar installations.
2. Dissimilar metals: Separate contacting surfaces with dielectric material.

C. Power transmission systems:
1. Power transmission equipment: V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a minimum service factor of 1.5:
   a. Apply 1.5 service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
   b. Apply service factors higher than 1.5 when recommended for continuous 24 hour per day operation and shock loadings in accordance with AGMA 6001-E08, other applicable AGMA standards, or other applicable referenced standards.
   c. When manufacturer recommends service factor greater than 1.5, manufacturer's recommendation takes precedence.

D. Vibration:
1. Resonant frequency:
   a. For single speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the operating rotational frequencies or multiples of the operating rotational frequencies that may be excited by the equipment design.
b. For variable speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the range of operating frequencies.

2. Design, balance, and align equipment to meet the vibration criteria specified in Section 15958.

E. Equipment mounting and anchoring:
1. Mount equipment on cast iron or welded steel bases with structural steel support frames.
   a. Utilize continuous welds to seal seams and contact edges between steel members.
   b. Grind welds smooth.
2. Provide bases and supports with machined support pads, dowels for alignment of mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits.
3. Provide jacking screws in bases and supports for equipment weighing over 1,000 pounds.
4. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load specified in Section 01612, and other loads as required for proper operation of equipment.
5. Anchorage of equipment to concrete or masonry:
   a. Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
   b. Unless otherwise indicated on the Drawings, select and provide anchors from the types specified in Section 05190.
   c. Provide bolt sleeves around cast-in anchor bolts for heavy equipment.
      1) Adjust bolts to final location and fill sleeve with polyurethane foam.
6. Anchorage of equipment to metal supports: Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.
7. Unless otherwise indicated on the Drawings, install equipment supported on concrete over non-shrink grout pads as specified in this Section.

F. Seismic design:
1. Design equipment anchorage and related details for seismic design criteria as specified in Section 01612.
2. For equipment with operating weight of 400 pounds and greater that is supported 4 feet or less above the floor and all equipment that is supported higher than 4 feet above the floor, provide calculations for:
   a. The operating weight and location of the centroid of mass for the equipment.
   b. Forces and overturning moments.
   c. Shear and tension forces in equipment anchorages, supports, and connections.
   d. The design of equipment anchorage, supports, and connections based on calculated shear and tension forces.

G. Equipment units weighing 50 pounds or more: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.
1.05 SUBMITTALS

A. All submittals shall follow requirements as specified in Contract Documents.

B. Product data:
   1. For each item of equipment:
      a. Design features.
      b. Load capacities.
      c. Efficiency ratings.
      d. Material designations by UNS alloy number or ASTM Specification and Grade.
      e. Data needed to verify compliance with the Specifications.
      f. Catalog data.
      g. Name plate data.
      h. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
   2. Gear reduction units:
      a. Engineering information in accordance with applicable AGMA standards.
      b. Gear mesh frequencies.

C. Shop drawings:
   1. Drawings for equipment:
      a. Drawings that include outline drawings, cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
   2. Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, base plate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
   3. Installation instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial Installation Testing procedures.
   4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer based controls.
   5. Recommended or normal operating parameters such as temperatures and pressures.
   6. Alarm and shutdown set points for all controls furnished.

D. Calculations:
   1. Calculations and other information to substantiate equipment base plates, supports, bolts, anchor bolts, and other connections meet minimum design strength requirements and seismic design criteria specified in Section 01612.
   2. ABMA 9 or ABMA 11 L10 life for bearings calculation methods for drivers, pumps, gears, shafts, motors, and other driveline components with bearings.
   3. Calculations and other information to substantiate that operating rotational frequencies meet the requirements of this Section.
   4. Torsional analysis of power transmission systems: When torsional analysis specified in the equipment sections, provide:
      a. Sketch of system components identifying physical characteristics including mass, diameter, thickness, and stiffness.
      b. Results of analysis including first and second critical frequencies of system components and complete system.
5. Calculations shall be signed and stamped by a civil or structural engineer registered to practice in the state where the Project is located.

E. Quality control submittals:
   1. Source quality control reports and certified test data as specified in Section 15958.
   2. Submit factory test reports before shipment.
   3. Certified static and dynamic balancing reports for rotating equipment.
   4. Field quality control reports and test data as specified in Section 15958.
   5. Submit material test reports a specified in the equipment sections.

F. Operation and maintenance manuals:
   1. As specified in Section 01782.
   2. Submit prior to training of Owner's personnel.
   3. Make available at project site complete copy of manuals for use by field personnel and Engineer during commissioning and process start-up of equipment.
   4. Include manufacturer and model number of every bearing; include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.

G. Commissioning and process start-up submittals: As specified in Section 01756.


1.06 QUALITY ASSURANCE

A. Manufacturer's field service:
   1. Furnish services of authorized representative specially trained in installation of equipment:
      a. Visit project site and perform tasks necessary to certify installation as specified in Section 01756.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Equipment: Pack in boxes, crates, or otherwise protect from damage and moisture, dust, or dirt during shipment, handling, and storage.
   2. Bearings: Separately pack or otherwise suitably protect during transport.
   3. Spare parts: Deliver in boxes labeled with contents, equipment to which spare parts belong, and name of Contractor.

B. Storage:
   1. Equipment having bearings:
      a. Store in enclosed facilities.
      b. Rotate units at least once per month or more often as recommended by the manufacturer to protect rotating elements and bearings.
   2. Gear boxes: Oil filled or sprayed with rust preventive protective coating.

C. Protection:
   1. Equipment: Protect equipment from deleterious exposure.
   2. Painted surfaces: Protect against impact, abrasion, discoloration, and other damage.
1.08 SEQUENCING AND SCHEDULING

A. Equipment anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place when concrete is placed.

B. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. Commissioning and process start-up submittals: As specified in Section 01756.
   1. Perform general commissioning and process start-up and testing procedures after operation and maintenance manuals for equipment have been received and accepted.
   2. Conduct functional testing of mechanical or electrical systems when each system is substantially complete and after general installation testing procedures have been successfully completed.
   3. Functional testing requirements as specified in Sections 01756, 15958, and the equipment sections.

1.09 MAINTENANCE

A. Special tools:
   1. When specified, provide special tools required for operation and maintenance.
   2. Mark or tag and list such tools in maintenance and operations instructions. Describe use of each tool.

B. Spare belts:
   1. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit:
      a. Where 2 or more belts are involved, furnish matched sets.
      b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
      c. Package in boxes labeled with identification of contents.

C. Spare parts:
   1. Assume responsibility until turned over to Owner.
   2. Store in enclosed facilities.
   3. Furnish itemized list and match identification tag attached to every part.
   4. List parts by generic title and identification number.
   5. Furnish name, address, and telephone number of supplier and spare parts warehouse.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials in contact with drinking water as specified in Section 01600.

B. Ferrous materials:
   1. Steel for members used in fabrication of assemblies: ASTM A36.
2. Iron castings: ASTM A48, tough, close-grained gray iron, free from blowholes, flaws, and other imperfections.
3. Ductile iron castings: ASTM A536, Grade 65-45-12, free from flaws and imperfections.
5. Expanded metal: ASTM A36, 13 gauge, 1/2-inch flat pattern expanded metal.

C. Nonferrous materials:
1. Stainless steel: Type 304 or 316 as specified. Provide L grade where welding required.
2. Bronze in contact with wastewater: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C89833, C89520 C92200, or C93700 in accordance with ASTM B61, B62, B505, or B584, when not specified otherwise.

D. Dielectric materials for separation of dissimilar metals:
1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials.

2.02 FASTENERS

A. General:
1. Material: As specified in the individual specifications.
2. Where fasteners are specified to be galvanized, shall be galvanized in accordance with ASTM A153 or ASTM F2329.

B. Mechanical anchors:
1. As specified in Section 01612 and Section 05190.

C. High-strength fasteners:
1. As specified in Section 05120.

D. Flange bolts:
1. As specified in Section 15052.

E. Mechanical assembly fasteners:
1. Stainless steel:
   a. High Temperature Service or High Pressure Service.
      1) Bolts: ASTM A193, Grade B8 (304 SST) or Grade B8M (316 SST), Class 1, heavy hex.
      2) Nuts: ASTM A194, Grade 8, heavy hex.
      3) Washers: Alloy group matching bolts and nuts.
   b. Low Temperature Service:
      1) Bolts: ASTM A320, Grade B8 (304 SST) or Grade B8M (316 SST), Class 1, heavy hex.
      2) Nuts: ASTM A194, Grade 8 (304 SST) or Grade B8M (316 SST), heavy hex.
      3) Washers: Alloy group matching bolts and nuts.
   c. General service:
      1) Bolts: ASTM F593, Alloy group 1 (304 SST) or Alloy group 2 (316 SST).
      2) Nuts: ASTM F594, Alloy group 1 (304 SST) or Alloy group 2 (316 SST).
3) Washers: Alloy group matching bolts and nuts.
2. Carbon Steel.

2.03 SHAFT COUPLINGS

A. General:
1. Type and ratings: Provide nonlubricated type, designed for not less than 50,000 hours of operating life.
2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, and type of service.
3. Use: Use of couplings specified in this Section does not relieve Contractor of responsibility to provide precision alignment of driver-driven units as required by equipment manufacturer and alignment criteria specified elsewhere in this Section.

B. Shaft couplings - close coupled: Shaft couplings for close coupled electric motor driven equipment 1/2 horsepower or larger and subject to sudden torque reversals or shock loading:
1. Manufacturers: One of the following or Engineer approved equal:
   a. T.B. Woods, Dura-Flex, L-Jaw, C-Jaw, or G-Jaw.
   b. Lovejoy, S-Flex.
2. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
3. Manufacture flexible component of coupling from synthetic rubber, or urethane.
4. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
5. Do not allow metal-to-metal contact between driver and driven equipment.
6. Examples of loads where sudden torque reversals may be expected:
   a. Reciprocating pumps, blowers, and compressors.
   b. Conveyor belts.
   c. Reversing equipment.

C. Shaft couplings - direct connected: Shaft couplings for direct connected electric motor driven equipment 1/2 horsepower or larger and subject to normal torque, non-reversing applications:
1. Manufacturers: One of the following or Engineer approved equal:
   a. Rexnord - Falk.
   b. T.B. Woods, Dura-Flex, Sure-Flex or Form-Flex.
2. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.
3. Provide flexible connecting element of rubber and reinforcement fibers.
4. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

D. Spacer couplings: Where cartridge type mechanical seals or non-split seals are specified, provide a spacer type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment unless noted otherwise in the individual equipment specifications.

E. Specialized couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer.
2.04 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:
1. Unless otherwise noted in the equipment section, provide cartridge type, double mechanical shaft seals for pumps.
2. Provide a stuffing box large enough for a double mechanical seal.
3. Where packing is specified, provide stuffing box large enough to receive a double mechanical seal.
4. Provide seal or packing flush connections, (3/4-inch size unless another size is indicated on the Drawings).
5. Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.
6. For pumps with packing, design packing gland to allow adjustment and repacking without dismantling pump except to open up packing box.
7. Seal or packing flush requirements shall be in accordance with API Standard 682 requirements. Unless otherwise indicated, specified or required by the equipment and seal manufacturers, the following API flushing Plan arrangements shall be utilized as appropriate for the application:
   a. Single seal, clean water applications: Plan 11 (Discharge bypass to seal).
   b. Single seal, vertical pump applications: Plan 13 (Seal bypass to suction).
   c. Single seal, clean hot water (greater than 180 degrees Fahrenheit) applications: Plan 23 (Seal cooler and pumping ring).
   d. Single seal, solids, or contaminants containing water applications: Plan 32 (External seal water- see Carollo typical detail # M262).
   e. Double seal applications: Plan 54 (External seal water- see Carollo typical detail # M262).

B. Packing: When specified in the equipment section of the specifications, provide the following type of packing:
1. Wastewater, water, and sludge applications:
   a. Asbestos free.
   b. PTFE (Teflon) free.
   c. Braided graphite.
   d. Manufacturers: One of the following or Engineer approved equal:
      1) Chesterton, 1400.
      2) John Crane Inc., equivalent product.
2. Drinking water service:
   a. Approved by the FDA.
   b. As specified in Section 01600.
   c. Asbestos free.
   d. Material: Braided PTFE (Teflon).
   e. Manufacturers: One of the following or Engineer approved equal:
      1) Chesterton, 1725.
      2) John Crane, Inc., equivalent product.

C. Mechanical seals: Provide seal types specified in the equipment sections and as specified.
1. Provide seal types meeting the following requirements:
   a. Balanced hydraulically.
   b. Spring: Stationary, out of pumping fluid, Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
d. Gland: Type 316L stainless steel.
e. Set screws: Type 316L stainless steel.
g. Seal designed to withstand 300 pounds per square inch gauge minimum differential pressures in either direction; no requirement for seal buffer pressure to be maintained when pump is not operational even though process suction head may be present in pump.

2. Cartridge type single mechanical: Manufacturers: One of the following or Engineer approved equal:
   a. Chesterton, S10.
   b. John Crane, 5610 Series.
3. Cartridge type double mechanical: Manufacturers: One of the following or Engineer approved equal:
   a. Chesterton, S20.
   b. John Crane, 5620 Series.
4. Split face single mechanical: Manufacturers: One of the following or Engineer approved equal:
   a. Chesterton, 442.
   b. John Crane, 3740.
5. Cartridge type flushless mechanical: Manufacturers: One of the following or Engineer approved equal:
   a. Chesterton, 156.
   b. John Crane, 5870.

2.05 GEAR REDUCTION UNITS

A. Type: Helical or herringbone, unless otherwise specified.

B. Design:
   1. Made of alloys treated for hardness and for severe service.
   2. AGMA Class II service:
      a. Use more severe service condition when such is recommended by unit's manufacturer.
   3. Cast iron housing with gears running in oil.
   4. Anti-friction bearings.
   5. Thermal horsepower rating based on maximum horsepower rating of prime mover not actual load.
   6. Manufactured in accordance with applicable AGMA standards.

C. Planetary gear units are not to be used.

2.06 BELT DRIVES

A. Sheaves:
   1. Separately mounted on bushings by means of at least 3 pull-up bolts or cap tightening screws.
   2. When 2 sheave sizes are specified, provide separate belts sized for each set of sheaves.
   3. Statically balanced for all; dynamically balanced for sheaves that operates at peripheral speed of more than 5,500 feet per minute.
   4. Key bushings to drive shaft.

B. Belts: Anti-static type when explosion-proof equipment or environment is specified.
C. Manufacturers: One of the following or Engineer approved equal:
   2. T.B. Wood's, Ultra-V belts with matching Sure-Grip sheaves and Sure-Grip bushings.

2.07 BEARINGS

A. Type: Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.

B. Oil lubricated bearings: Provide either pressure lubricating system or separate oil reservoir splash type system:
   1. Size oil lubrication systems to safely absorb heat energy generated in bearings when equipment is operating under normal conditions and with the temperature 15 degree Fahrenheit above the maximum design temperature as specified in Section 01610.
   2. Provide an external oil cooler when required to satisfy the specified operating conditions.
      a. Provide air cooled system if a water-cooling source is not indicated on the Drawings.
      b. Equip oil cooler with a filler pipe and external level gauge.

C. Grease lubricated bearings, except those specified to be factory sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings.
   1. Lubrication lines and fittings:
      a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
      b. Multiple fitting assemblies: Mount fittings together in easily accessible location.
      c. Use standard hydraulic type grease supply fittings:
         1) Manufacturers: One of the following or Engineer approved equal:
            a) Alenite.
            b) Zerk.

D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 L10 life for bearings rating life of not less than 50,000 hours:
   1. Higher ratings, when specified in other Sections, supersede preceding requirement.

2.08 SAFETY GUARDS

A. Drive assemblies: Enclose sprockets, belts, drive chains, gearings, couplings, and other moving parts on drive assemblies in safety enclosures that are in compliance with applicable Laws and Regulations.

B. Shafts: Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms.

C. Hot surfaces: Insulate all surfaces with normal operating temperatures above 120 degrees Fahrenheit when surface is within 7.5 feet height from any operating floor or level; insulation thickness such that temperature is below 120 degrees Fahrenheit; cover insulation with moisture-proof protective jacket; insulation Type 3 and cover Type 5 as specified in Section 15082.
D. Guard requirements:
   1. Allow visual inspection of moving parts without removal.
   2. Allow access to lubrication fittings.
   3. Prevent entrance of rain or dripping water for outdoor locations.
   4. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of 1 belt.

E. Materials:
   1. Sheet metal: Carbon steel, 12 gauge minimum thickness, hot-dip galvanized after fabrication.
   2. Fasteners: Type 304 stainless steel.

2.09 SPRING VIBRATION ISOLATORS

A. Design requirements:
   1. Telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces.
   2. Use steel coil springs.
   3. Design vibration isolators in accordance with seismic design criteria as specified in Section 01612.

B. Performance requirements: Minimum spring deflection of 1 inch under static load and capable of limiting transmissibility to 15 percent maximum at design operating load.

C. Manufacturers: One of the following or Engineer approved equal:
   1. California Dynamics Corporation, Type RJSD.
   2. Mason Industries, equivalent product.

D. Materials:
   1. Fabricate isolators using welded steel or shatterproof ductile iron in accordance with ASTM A536 Grade CS-45-12.

2.10 WARNING SIGNS

A. Provide for equipment that starts automatically or remotely.

B. Colors: Black lettering on yellow background.

2.11 FABRICATION

A. Structural steel members: As specified in Section 05120.

B. Nameplates:
   1. Engraved or stamped on Type 304 stainless steel and fastened to equipment at factory in an accessible and visible location.
   2. Indicate following information as applicable:
      a. Manufacturer's name.
      b. Equipment model number and serial number.
      c. Maximum and Normal rotating speed.
      d. Horsepower.
      e. Rated capacity.
      f. Service class per applicable standards.
3. Nameplates for pumps: Include:
   a. Rated total dynamic head in feet of fluid.
   b. Rated flow in gallons per minute.
   c. Impeller, gear, screw, diaphragm, or piston size.
4. Gear reduction units: Include:
   a. AGMA Class of service.
   b. Service factor.
   c. Input and output speeds.

C. Bolt holes in equipment support frames:
   1. Do not exceed bolt diameter by more than 25 percent, up to limiting maximum
diameter oversize of 1/4 inch.

D. Shop finishing:
   1. Provide factory and field coating as specified in Section 09960.
      a. Finish painting of motors: Shop finish paint with manufacturer's standard
         coating, unless otherwise specified in Section 09960.

2.12 SOURCE QUALITY CONTROL

A. As specified in Section 15958 for testing requirements and the individual equipment
sections of the Specifications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage, conformance to specifications, and
   proper torques and tightness of fasteners.

3.02 PREPARATION

A. Metal work embedded in concrete:
   1. Accurately place and hold in correct position while concrete is being placed.
   2. Clean surface of metal in contact with concrete immediately before concrete is
      placed.

B. Concrete surfaces designated to receive non-shrink grout:
   1. Heavy sandblast concrete surface in contact with non-shrink grout.
   2. Clean concrete surfaces of sandblasting sand, grease, oil, dirt, and other
      foreign material that may reduce bond to non-shrink grout.
   3. Saturate concrete with water. Concrete shall be saturated surface damp at
time non-shrink grout is placed.

C. Field measurements:
   1. Prior to fabrication of equipment, take measurements for installation of
      equipment and verify dimensions indicated on the Drawings.
   2. Ensure equipment and ancillary appurtenances fit within available space.
3.03 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions and recommendations.

B. Lubrication lines and fittings:
   1. Lines from fittings to point of use: Support and protect.
   2. Fittings:
      a. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
      b. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
      c. Fittings for underwater bearings: Bring fittings above water surface and mount on edge of structure above.

C. Special techniques: Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

D. Tolerances:
   1. Completed equipment installations: Comply with requirements for intended use and specified vibration and noise tolerances.

E. Warning signs: Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.04 FIELD QUALITY CONTROL

A. Test equipment as specified in Section 15958 and the individual equipment section of the Specifications.

3.05 COMMISSIONING AND PROCESS START-UP

A. Perform commissioning and process start-up: As specified in Section 01756.

END OF SECTION
SECTION 15052
COMMON WORK RESULTS FOR GENERAL PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic piping materials and methods.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as
      binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of
      subcontractors, suppliers, and other individuals or entities performing or
      furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This
      list of Related Sections is provided for convenience only and is not intended to
      excuse or otherwise diminish the duty of the Contractor to see that the
      completed Work complies accurately with the Contract Documents.
      b. Section 09960 - High-Performance Coatings.
      c. Section 15249 - Polyvinyl Chloride (PVC): Schedule Type.
      d. Section 15286 - Stainless Steel Pipe.
      e. Section 15956 - Piping Systems Testing.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   2. B16.47 - Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch
      Standard.

B. American Water Work Association (AWWA):
      Through 144 In.

C. ASTM International (ASTM):
   1. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting
      Materials for High Temperature or High Pressure Service and Other Special
      Purpose Applications.
   2. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for
      High Pressure or High Temperature Service, or Both.
   3. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI
      Tensile Strength.
1.03 DEFINITIONS

A. Buried pipe: Pipe that is buried in the soil, or cast in a concrete pipe encasement that is buried in the soil.

B. Exposed pipe: Pipe that is located above ground, or pipe that is located inside a structure, supported by a structure, or cast into a concrete structure.

C. Underground piping: Piping actually buried in soil or cast in concrete that is buried in soil.

D. Underwater piping: Piping below tops of walls in basins or tanks containing water.

E. Wet wall: Wall with water on at least 1 side.

1.04 SUBMITTALS

A. Product data:
   1. Escutcheons.
   2. Flange bolts.
   4. Grooved joint couplings and fittings.
   5. Link-type seals.

B. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756.

C. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756.

PART 2 PRODUCTS

2.01 ESCUTCHEONS

A. Material: Chrome-plated steel plate.

B. Manufacturers: One of the following or Engineer approved equal:
   1. Dearborn Brass Company, Model Number 5358.
   2. Keeney Manufacturing Company, Model Number 102 or Number 105.

2.02 LINK TYPE SEALS

A. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a nylon polymer pressure plate with Type 316 stainless steel hardware. Isolate pressure plate from contact with wall sleeve.

B. Manufacturers: One of the following or Engineer approved equal:
   2. Pipeline Seal and Insulator, Inc., Link-Seal.
2.03 FLANGE BOLTS

A. Plastic pipe:
1. Bolts and nuts for flanges on plastic pipe located indoors, outdoors above ground, or in dry vaults and structures shall be hot-dip galvanized carbon steel, in accordance with ASTM A307, Grade B for bolts and in accordance with ASTM A563, Grade A for nuts.
2. Bolts and nuts for flanges on plastic pipe submerged in water or wastewater, buried, in wet vaults or structures, adjacent to wet walls, or above open water-containing structures and plastic pipe carrying corrosive chemicals shall be Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts and in accordance with ASTM A194, Grade 8M for nuts.
3. Provide a washer for each nut. Washer shall be of the same material as the nut.
4. Nuts shall be Heavy hex-head.
5. Cut and finish flange bolts to project a maximum of 1/4 inch beyond outside face of nut after assembly.
6. Tap holes for cap screws or stud bolts when used.

B. Steel pipe:
1. Bolts and nuts for ASME B16.5 Class 150 flanges and AWWA C207 Class D flanges located indoors, outdoors above ground, or in dry vaults and structures shall be hot-dip galvanized carbon steel, ASTM A307, Grade B for bolts and in accordance with ASTM A563, Grade A for nuts.
2. Bolts and nuts for ASME B16.5 and B16.47 Class 300 flanges and AWWA C207 Class E and F flanges located indoors, outdoors above ground, or in dry vaults and structures in accordance with ASTM A193, Grade B7 for bolts and in accordance with ASTM A194, Grade 2H for nuts.
3. Bolts and nuts for flanges submerged in water or wastewater, buried, in wet vaults or structures, adjacent to wet walls, or above open water-containing structures shall be Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts and in accordance with ASTM A194, Grade 8M for nuts.
4. Provide a washer for each nut. Washer shall be of the same material as the nut.
5. Nuts shall be Heavy hex-head.
6. Cut and finish flange bolts to project a maximum of 1/4 inch beyond outside face of nut after assembly.
7. Tap holes for cap screws or stud bolts when used.

C. Lubricant for stainless steel bolts and nuts:
1. Chloride-free.
2. Manufacturers: One of the following or Engineer approved equal:

2.04 GASKETS

A. Gaskets for non-steam cleaned ductile iron and steel piping:
1. Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 250 degrees Fahrenheit, and raw sewage service.
2. Gasket material:
   a. Neoprene elastomer with minimum Shore A hardness value of 70.
b. Reinforcement: Inserted 13-ounce nylon fabric cloth for pipes 20 inch or larger.
c. Thickness: Minimum 3/32-inch thick for less than 10-inch pipe; minimum 1/8 inch thick for 10-inch and larger pipe.

3. Manufacturers: One of the following or Engineer approved equal:
   a. Pipe less than 20 inches in diameter:
      1) Garlock, Style 7797.
      2) John Crane, similar product.
   b. Pipe 20 inches in diameter and larger:
      1) Garlock, Style 8798.
      2) John Crane, similar product.

B. Gaskets for non-steam cleaned grooved end ductile iron and steel piping:
   1. Suitable for pressures equal to the encapsulating coupling or flange adapter.
      a. Ductile iron piping: FlushSeal® type.
         1) Halogenated Butyl: Grade M; for temperatures to 200 degrees Fahrenheit.
         2) Nitrile: Grade S; for temperatures to 180 degrees Fahrenheit.
      b. Steel piping:
         1) EPDM: Grade E; for temperatures to 230 degrees Fahrenheit.
         2) EPDM-HP: Grade EHP, for temperatures to 250 degrees Fahrenheit.
         3) Nitrile: Grade T, for temperatures to 180 degrees Fahrenheit.
   3. Gaskets shall be verified as suitable for the intended service.
      a. Temperature ratings may vary depending on the fluid/media.
   4. Manufacturers: Gaskets shall be of the same manufacturer as the encapsulating couplings/flange adapters.
      a. Victaulic Company.

C. Gaskets for steam cleaned non glass-lined ductile iron and steel piping:
   1. Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 360 degrees Fahrenheit, and raw sewage service.
   2. Material:
      a. Neoprene elastomer, compressed, non-asbestos fiber reinforcement.
   3. Manufacturers: One of the following or Engineer approved equal:
      a. Garlock, Bluegard 3300.
      b. John Crane, similar product.

D. Gaskets for steam cleaned glass lined ductile iron piping:
   1. Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 360 degrees Fahrenheit, and sludge service.
   2. Material:
      a. Teflon gasketing with 1/16-inch sheet thickness each side (1/8 inch total sheet thickness), filled with corrugated or perforated Type 316 stainless steel ring and non-asbestos filler material with minimum 5/16-inch overall thickness.
   3. Manufacturers: One of the following or Engineer approved equal:
      a. Garlock, Style HP3561.
      b. John Crane, similar product.
E. Gaskets for flanged joints in polyvinyl chloride and polyethylene piping:
1. Suitable for pressures equal and less than 150 pounds per square inch gauge, with low flange bolt loadings, temperatures equal and less than 120 degrees Fahrenheit, and polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine including fluorochemicals and gaseous fluorine.
2. Material: 0.125-inch thick Viton rubber.
3. Manufacturers: One of the following or Engineer approved equal:
   a. Garlock.
   b. John Crane, similar product.

F. Gaskets for flanged joints in gas or liquefied petroleum gas piping:
1. Digester gas in stainless steel, or black steel piping: Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 200 degrees Fahrenheit, and digester gas and mild acid concentrations.
2. Chlorine gas application in black steel piping: Suitable for pressures equal to or less than 300 pounds per square inch gauge, temperatures equal to or less than 100 degrees Fahrenheit, and chlorine gas application.
3. Liquefied petroleum, propane, and natural gas applications in black steel piping: Suitable for pressures equal and less than 250 pounds per square inch gauge, temperatures equal and less than 100 degrees Fahrenheit, and liquefied petroleum gas, propane gas, and natural gas application.
4. Material:
   a. Microcellular Teflon outer layers with rigid center layer.
   b. Sealability in accordance with ASTM F37, less than 0.55 millimeter per hour leakage of iso-octane at 1,000 pounds per square inch gasket load and 9.8 pounds per square inch fluid pressure.
5. Manufacturers: One of the following or Engineer approved equal:
   a. Garlock, Style 3545.
   b. John Crane, similar product.

G. Gaskets for flanged joints in low pressure air piping:
1. Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 300 degrees Fahrenheit, and compressed air service.
3. Manufacturers: One of the following or Engineer approved equal:
   a. Garlock, Style 8314.
   b. John Crane, similar product.

H. Gaskets for flanged joints in ductile iron or steel water piping:
1. Suitable for hot or cold water, pressures equal and less than 150 pounds per square inch gauge, and temperatures equal and less than 160 degrees Fahrenheit.
2. Material:
   a. Neoprene elastomer, compressed, with non-asbestos fiber reinforcement.
   b. Teflon ring; or Teflon envelope with non-asbestos filler.
3. Manufacturers: One of the following or Engineer approved equal:
   a. Garlock, Bluegard 3300.
   b. John Crane, similar product.
I. Gaskets for flanged joints in ductile iron or steel drinking water piping meeting NSF requirements:
   1. Suitable for hot or cold water, pressures equal to or less than 150 pounds per square inch gauge, and temperatures equal to or less than 160 degrees Fahrenheit.
   2. Material:
      a. PTFE material with glass microsphere filler.
   3. Manufacturers: One of the following or Engineer approved equal:
      a. Garlock, GYLON® Style 3505.
      b. John Crane, similar product.

J. Provide gaskets suitable for the specific fluids and pressure and temperature conditions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of existing conditions:
   1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions that may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
   2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
   3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 COMMISSIONING AND PROCESS START-UP REQUIREMENTS

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.
      a. Functional Testing: for watertight installations only.

3.03 INSTALLATION

A. General:
   1. Piping drawings:
      a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
      b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
         1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.
2. Piping alternatives:
   a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
   b. Alternative pipe ratings:
      1) Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price.
      2) Piping of different material may not be substituted in lieu of specified piping.
   c. Valves in piping sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
   d. For grooved joints, use couplings, flange adapters, and fittings of the same manufacturer.
      1) The grooved joint manufacturer's factory trained representative shall provide on-site training for Contractor's field personnel in
      2) The representative shall periodically visit the jobsite and review Contractor is following best recommended practices in grooved product installation.
      3) A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).
   e. For flanged joints, where 1 of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.

3. Unless otherwise indicated on the Drawings, piping at pipe joints, fittings, couplings, and equipment shall be installed without rotation, angular deflection, vertical offset, or horizontal offset.

B. Exposed piping:
   1. Install exposed piping in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings:
      a. Install piping runs plumb and level, unless otherwise indicated on the Drawings.
         1) Slope plumbing drain piping with a minimum of 1/4 inch per foot downward in the direction of flow.
         2) Slope digester gas piping to drip traps or low-point drains at a minimum of 1/2 inch per foot where condensate flows against the gas, or at a minimum of 1/4 inch per foot where condensate flows with gas.
   2. Install exposed piping after installing equipment and after piping and fitting locations have been determined.
   3. Support piping:
      a. Do not transfer pipe loads and strain to equipment.
   4. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
   5. Assemble piping without distortion or stresses caused by misalignment:
      a. Match and properly orient flanges, unions, flexible couplings, and other connections.
      b. Do not subject piping to bending or other undue stresses when fitting piping.
      c. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
      d. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
e. Alter piping assembly to fit, when proper fit is not obtained.
f. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

C. Restraining piping:
   1. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
      a. When piping is underground, use concrete thrust blocks, mechanical restraints, or push-on restraints.
      b. When piping is aboveground or underwater, use mechanical or structural restraints.
      c. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by design test pressure of the piping.
   2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
      a. During testing, provide suitable temporary restraints where piping does not require permanent restraints.

D. Flanged connections between dissimilar metals such as ductile iron pipe and steel pipe:
   1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.04 CLEANING

A. Piping cleaning:
   1. Upon completion of installation, clean piping interior of foreign matter and debris.
   2. Perform special cleaning when required by the Contract Documents.

3.05 PIPING SCHEDULE
# PIPING SCHEDULE

<table>
<thead>
<tr>
<th>Process Abbrev.</th>
<th>Service</th>
<th>Nominal Diameter (inches)</th>
<th>Material</th>
<th>Pressure Class Special Thickness Class Schedule Wall Thickness</th>
<th>Pipe Spec. Section</th>
<th>Joints/Fittings</th>
<th>Test Pressure/Method</th>
<th>Lining</th>
<th>Coating</th>
<th>Service Cond</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPW</td>
<td>Non-Potable Water</td>
<td>Aboveground 3 and Under</td>
<td>PVC</td>
<td>SCH 80</td>
<td>15249</td>
<td>SW</td>
<td>175 psig/HH</td>
<td>None</td>
<td>Latex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POS</td>
<td>Polymer Solution</td>
<td>Aboveground All</td>
<td>PVC</td>
<td>SCH 80</td>
<td>15249</td>
<td>SW</td>
<td>125 psig/HH</td>
<td>None</td>
<td>Latex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAM</td>
<td>Sample Line</td>
<td>Aboveground All</td>
<td>PVC</td>
<td>SCH 80</td>
<td>15249</td>
<td>SW</td>
<td>125 psig/HH</td>
<td>None</td>
<td>Latex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW</td>
<td>Seal Water</td>
<td>Exposed 0.5 - 1</td>
<td>PVC</td>
<td>SCH 80</td>
<td>15249</td>
<td>SW</td>
<td>125 psig/HH</td>
<td>None</td>
<td>Latex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UWAS, TWAS</td>
<td>Unthickened Waste Activated Sludge, Thickened Waste Activated Sludge</td>
<td>Above Ground All</td>
<td>316L SST</td>
<td>15286</td>
<td>FL</td>
<td>150 psig/HH</td>
<td>None</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:**
1. The following abbreviations used in the column of test method refer to the respective methods as specified in Section 15956.
   - AM Air method
   - GR Gravity method
   - HH High head method
   - LH Low head method
   - SC Special case
   - GA Gauge, preceded by the designation
   - GE Grooved end joint
   - GL Glass lined
   - GSP Galvanized steel pipe
   - MJ Mechanical joint
   - NPS Nominal pipe size, followed by the number in inches
   - psi pounds per square inch
   - psig pounds per square inch gauge
   - PE Polyethylene
   - PEE Polyethylene encasement
   - PTW Polyethylene tape wrap
   - PVC Polyvinyl Chloride
   - SCH Schedule, followed by the designation
   - SCRD Screwed-On
   - SST Stainless steel
   - SW Solvent welded
   - VCP Vitrified clay piping
   - WAE Waterborne acrylic emulsion
   - WLD Weld
SECTION 15118
PRESSURE REDUCING VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pressure reducing valves for water and chemical service.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):

B. ASTM International (ASTM):

C. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. As specified in Section 15110.

PART 2 PRODUCTS

2.01 WATER PRESSURE REDUCING VALVES

A. Water pressure reducing valves, 2 1/2 inches and smaller:
   1. Manufacturers: One of the following or Engineer approved equal:
      a. Watts Regulator, Series LF223.
      b. Wilkins, 500 Series.
   2. Direct operated, single seat type pressure reducing valve.
   3. Materials:
      a. Body and spring cover: Bronze.
      b. Valve seat: Series 300 stainless steel.
      c. Diaphragm: Buna Nitrile or EPDM.
      d. Disk: Buna Nitrile or EPDM.
B. Water pressure reducing valves, 3 inches and larger:
   1. Manufacturers: One of the following, or Engineer approved equal:
      a. Watts ACV Series 115.
      b. Cla-Val Model 90-01.
   2. Design:
      a. Pilot controlled, hydraulically operated, diaphragm actuated, globe
         patterned valve.
      b. Rated for 125 pounds per square inch gauge.
      c. Pilot line: Equipped with a strainer.
      d. Flanges: 150-pound rating, in accordance with ASME B16.42.
   3. Materials:
      a. Body and cover: Cast iron ASTM A48 or Ductile Iron ASTM A536.
      b. Valve trim: Bronze.
      c. Pilot control: Cast bronze with Series 303 stainless steel trim.
      d. Diaphragm: Nylon reinforced Buna N.

2.02 PRESSURE RELIEF VALVES FOR CHEMICAL SERVICE

A. Manufacturers: One of the following or Engineer approved equal:
   1. Plast-O-Matic, Series RVT, RVDT or TRVDT.
   2. Asahi/America.

B. Materials:
   1. Valve body: CPVC or PVC.
   2. U-cup seals:
      a. Polymer service: Viton.
      b. Hypochlorite service: Viton.
      c. Caustic service: EPDM.
      d. Sodium Bisulfite: EPDM.
   3. Adjusting bolt, locknut, control spring, and fasteners: stainless steel.

C. Design:
   1. Pressure rating: Not less than 150 pounds per square inch.
   2. In-line or angle pattern design, size as indicated on the Drawings.
   3. End connections:
      a. 1 inch and smaller: Threaded.
      b. Larger than 1 inch: Flanged.
   4. Relief set point:
      a. Externally adjustable without removing valve from piping system.
      b. Set valve to open at 10 pounds per square inch more than pump
         discharge pressure at operating point, or as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with Section 15110.
3.02 COMMISSIONING AND PROCESS START-UP REQUIREMENTS

A. As specified in Section 01756 and this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. As specified in Section 15110.

END OF SECTION
SECTION 15125
STRAINERS

PART 1   GENERAL

1.01 SUMMARY

A. Section includes: Strainers.

B. Related section:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
      b. Section 01782 - Operation and Maintenance Data.
      c. Section 15052 - Common Work Results for General Piping.
      d. Section 15956 - Piping Systems Testing.

1.02 REFERENCES

A. ASTM International (ASTM):

B. Society of Automotive Engineers (SAE).

1.03 SUBMITTALS

A. Submit as specified in Contract Documents.

B. Product data:
   1. Shop drawings, detailing dimensions, and materials.
   2. Installation instructions.

C. Provide vendor operation and maintenance manual as specified in Section 01782.
   1. Furnish bound sets of installation, operation, and maintenance instructions for each type strainer. Include information on valves for mechanically-cleaned strainers.

D. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756.

E. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.
PART 2  PRODUCTS

2.01  Y-TYPE STRAINERS

A. Y-type strainers 4 inches and larger in diameter:
   1. Materials:
      a. Bodies: Cast iron or semi-steel.
      b. Ends: Flanged.
      c. Screens: Brass or Type 304 stainless steel.
   2. Suitable for following minimum pressure conditions:
      a. Steam service: 250 pounds per square inch gauge.
      b. Water, oil, and gas service: 200 pounds per square inch gauge.
   3. Perforated screens:
      a. Openings: 0.045 inch.
      b. Active screen opening to pipe area ratio: 2.8, minimum.
      c. Free area: 37 percent minimum.
   4. Manufacturers: One of the following or Engineer approved equal:
      b. ITT/Hoffman, 460 Series.

B. Y-type strainers less than 4 inches in diameter:
   1. Materials:
      a. Bodies: Cast iron or semi-steel.
      b. Ends: Flanged or threaded.
      c. Screen: Brass or Type 304 stainless steel.
   2. Suitable for minimum pressure of 250 pounds per square inch gauge.
   4. Manufacturers: One of the following or Engineer approved equal:
      a. Armstrong, Y-Type Strainer.

PART 3  EXECUTION

3.01  INSTALLATION

A. Install in accordance with the manufacturer's recommendations.

END OF SECTION
SECTION 15249

POLYVINYL CHLORIDE (PVC) PIPE: SCHEDULE TYPE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Schedule type PVC pipe and fittings.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01330 - Submittal Procedures.
      c. Section 15052 - Common Work Results for General Process Piping.
      d. Section 15956 - Piping Systems Testing.

1.02 REFERENCES

A. ASTM International (ASTM):

B. NSF International (NSF):
   1. 61 - Drinking Water System Components – Health Effects.

1.03 SUBMITTALS

A. Submit as specified in Section 01330.

B. Shop Drawings:
   1. Describe materials, pipe, fittings, gaskets, and solvent cement.
   2. Installation instructions.
C. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756. Include as applicable:
   1. Date of manufacture of tubing for each lot delivered.
   2. Solvent cement manufacturer's report and certification.

D. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

**1.04 QUALITY ASSURANCE**

A. Pipe in potable water applications: Provide pipe bearing NSF 61 seal.

B. Mark pipe and fittings in accordance with ASTM D1785.

**1.05 DELIVERY, STORAGE, AND HANDLING**

A. Protect from sunlight, scoring, and distortion.

B. Do not allow surface temperatures to exceed 120 degrees Fahrenheit.

C. Store and handle as recommended by manufacturer in published instructions.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

A. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

1. Pipe: Designation PVC 1120 in accordance with ASTM D1785 and appendices:
   a. Extruded from Type I, Grade 1, Class 12454-B material in accordance with ASTM D1784.
   b. Schedule 80 unless otherwise indicated on the Drawings or specified in the Piping Schedule in Section 15052.

2. Fittings: In accordance with ASTM D2467.
   a. Same material as the pipe and of equal or greater pressure rating.
   b. Supplied by pipe manufacturer.
   c. Unions 2-1/2 inches and smaller:
      1) Use socket end screwed unions.
   d. Unions 3 inches and larger:
      1) Use socket flanges with 1/8-inch full-face soft Viton gasket.

3. Solvent cement:
   a. In accordance with ASTM D2564.
   b. Manufacturers: The following or Engineer approved equal:
      1) IPS Corporation.
   c. Certified by the manufacturer for the service of the pipe.
   d. In potable water applications: Provide solvent cement listed by NSF for potable water applications.
   e. Primer: As recommended by the solvent cement manufacturer.
2.02 SOURCE QUALITY CONTROL
   A. Meets or exceeds all quality assurance test requirements stated in ASTM D1785.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install piping in accordance with ASTM F645, or manufacturer's published
      instructions for installation of piping, as applicable.
   B. Provide molded transition fittings for transitions from plastic to metal pipe.
      1. Do not thread pipe.
   C. Locate unions where indicated on the Drawings, and elsewhere where required for
      adequate access and assembly of the piping system.
   D. Provide serrated nipples for transition from pipe to rubber hose.
   E. Solvent weld joints in accordance with ASTM D2855.

3.02 FIELD QUALITY CONTROL
   A. Test pipe as specified in Section 15052 and Section 15956.

3.03 COMMISSIONING AND PROCESS START-UP REQUIREMENTS
   A. As specified in Section 01756 and this Section.
   B. Manufacturer services:
      1. Provide Manufacturer's Certificate of Source Testing.
      2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

END OF SECTION
SECTION 15286
STAINLESS STEEL PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Stainless steel piping and tubing.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01330 - Submittal Procedures.
      c. Section 09960 - High-Performance Coatings.
      d. Section 15052 - Common Work Results for General Piping.
      e. Section 15121 - Pipe Couplings and External Joint Restraints.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):

B. American Welding Society (AWS):
   1. D1.6 - Structural Welding Code - Stainless Steel.

C. ASTM International (ASTM):
   2. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   3. A194 - Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High Pressure or High Temperature Service, or Both.

D. NSF International (NSF):

1.03 DESIGN REQUIREMENTS

A. Piping layout: Lay out and fabricate piping systems with piping sections as long as possible, while still allowing shipment, so that joints are minimized.
   1. Piping design indicated on the Drawings illustrates piping layout and configuration and does not indicate the location of every 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.

B. Shop fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture.

C. Field assembly:
   1. Field welding is prohibited.
1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Shop Drawings:
   1. Detailed layout drawings:
      a. Dimensions and alignment of pipes.
      b. Location of valves, fittings, and appurtenances.
      c. Location of field joints.
      d. Location of pipe hangars and supports.
      e. Connections to equipment and structures.
      f. Location and details of shop welds.
   2. Thickness and dimensions of fittings and gaskets.
   3. Photographs, drawings, and descriptions of pipe, fittings, welding procedures, and pickling and passivating procedures.
   4. Material specifications for pipe, gaskets, fittings, and couplings.
   5. Data on joint types and components used in the system including flanged joints, grooved joint couplings, and screwed joints.

C. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756.

D. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

PART 2 PRODUCTS

2.01 STAINLESS STEEL PIPE

A. General:
   1. Pipe sizes specified in the Specifications and indicated on the Drawings are nominal.

B. Wall thickness:
   1. Piping 3 inches in nominal diameter and greater:
      a. For general service applications with pressures less than 250 pounds per square inch gauge, pipe diameter 24 inches or less, minimum wall thickness corresponding to Schedule 10S.
      b. For pressures exceeding 250 pounds per square gauge, minimum wall thickness corresponding to Schedule 40S.
   2. Piping less than 3 inches in nominal diameter:
      a. Piping with threaded or grooved joints:
         1) Minimum wall thickness corresponding to Schedule 40S.
      b. Piping with Vic-Press joints:
         1) Minimum wall thickness corresponding to Schedule 10S.
   3. Piping with threaded or grooved joints:
      a. For general service applications with pressures less than 250 pounds per square inch gauge, minimum wall thickness corresponding to Schedule 40S.
      b. For pressures exceeding 250 pounds per square inch gauge, minimum wall thickness corresponding to Schedule 80S.
C. Piping material and manufacturing:
   1. Comply with the requirements outlined in the following table:

<table>
<thead>
<tr>
<th>Service</th>
<th>Stainless Steel Grade</th>
<th>Pipe Manufacturing Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>For low chloride water service with chloride concentrates below 200 parts per million and/or free chlorine less than 2 parts per million at ambient temperatures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping 3 inches in nominal diameter and larger</td>
<td>Type 304L stainless steel in accordance with ASTM A240</td>
<td>In accordance with ASTM A778</td>
</tr>
<tr>
<td>Piping less than 3 inches in nominal diameter</td>
<td>Type 304L stainless steel in accordance with ASTM A240</td>
<td>In accordance with ASTM A312</td>
</tr>
<tr>
<td>Digester Gas, Oxygen and Ozone Service, Membrane and Reverse Osmosis Filtration Systems with chloride concentrations less than 1,000 parts per million and/or free chlorine less than 4 parts per million at ambient temperatures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping 3 inches in nominal diameter and larger</td>
<td>Type 316L or LDX 2101 stainless steel in accordance with ASTM A240</td>
<td>Type 316L in accordance with ASTM A778</td>
</tr>
<tr>
<td>Piping less than 3 inches in nominal diameter</td>
<td>Type 316L or LDX 2101 stainless steel in accordance with ASTM A240</td>
<td>Type LDX 2101 in accordance with ASTM A790</td>
</tr>
<tr>
<td>Brackish water Membrane and Reverse Osmosis Membrane Filtration Systems with chloride concentrations between 1,000 and 10,000 parts per million.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All piping diameters</td>
<td>Austenitic or duplex grades of material with PREN greater than 33</td>
<td>In accordance with ASTM A312, ASTM A778, ASTM A790, or ASTM A928</td>
</tr>
<tr>
<td>Brackish and Seawater Membrane and Reverse Osmosis Membrane Filtration Systems with chloride concentrations between 10,000 to 20,000 parts per million.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All piping diameters</td>
<td>Austenitic or duplex grades of material with PREN greater than 40</td>
<td>In accordance with ASTM A312, ASTM A790 or ASTM A928</td>
</tr>
<tr>
<td>Brackish and Seawater Reverse Osmosis Concentrate (i.e., Brine) with chloride concentrations greater than 20,000 parts per million.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All piping diameters</td>
<td>Austenitic or duplex grades of material with PREN greater than 45</td>
<td>In accordance with ASTM A312, ASTM A778, ASTM A790, or ASTM A928</td>
</tr>
</tbody>
</table>

PREN: Pitting Resistance Equivalency Number
PREN = Cr% + (3.3 x Mo%) + (16 x N%)
<table>
<thead>
<tr>
<th>UNS #</th>
<th>ALLOY</th>
<th>Cr%</th>
<th>Mo%</th>
<th>N%</th>
<th>Other</th>
<th>PREN</th>
</tr>
</thead>
<tbody>
<tr>
<td>N10276</td>
<td>C-276</td>
<td>14.5-16</td>
<td>15-17</td>
<td>-</td>
<td>W 3-4.5</td>
<td>64</td>
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<tr>
<td>S32750</td>
<td>Alloy 2507</td>
<td>24-26</td>
<td>6-8</td>
<td>0.24-0.32</td>
<td>-</td>
<td>48</td>
</tr>
<tr>
<td>S32654</td>
<td>654SMO</td>
<td>24-25</td>
<td>7-8</td>
<td>-</td>
<td>-</td>
<td>47</td>
</tr>
<tr>
<td>N06625</td>
<td>Alloy 625</td>
<td>20-23</td>
<td>8-10</td>
<td>-</td>
<td>Cb 3.25-4.15</td>
<td>46</td>
</tr>
<tr>
<td>N08366</td>
<td>AL6XN</td>
<td>20-22</td>
<td>6-7</td>
<td>-</td>
<td>-</td>
<td>40</td>
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<tr>
<td>N06985</td>
<td>Alloy G</td>
<td>21-23.5</td>
<td>5.5-7.5</td>
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<td>-</td>
<td>39</td>
</tr>
<tr>
<td>S32760</td>
<td>Zeron 100</td>
<td>24-26</td>
<td>3-4</td>
<td>0.2-0.3</td>
<td>W 0.5-1.0</td>
<td>37</td>
</tr>
<tr>
<td>S32205</td>
<td>Alloy 2205</td>
<td>22-23</td>
<td>3-3.5</td>
<td>0.14-0.20</td>
<td>-</td>
<td>34</td>
</tr>
<tr>
<td>N08904</td>
<td>904L</td>
<td>19-23</td>
<td>4-5</td>
<td>-</td>
<td>-</td>
<td>32</td>
</tr>
<tr>
<td>S31726</td>
<td>317LNM</td>
<td>17-20</td>
<td>4-5</td>
<td>0.1-0.2</td>
<td>-</td>
<td>32</td>
</tr>
<tr>
<td>N08825</td>
<td>Alloy 825</td>
<td>19-23.5</td>
<td>2.5-3.5</td>
<td>-</td>
<td>-</td>
<td>27</td>
</tr>
<tr>
<td>S32101</td>
<td>LDX-2101</td>
<td>21.5</td>
<td>0.3</td>
<td>0.22</td>
<td>-</td>
<td>26</td>
</tr>
<tr>
<td>S31603</td>
<td>316L</td>
<td>16-18</td>
<td>2-3</td>
<td>-</td>
<td>-</td>
<td>23</td>
</tr>
<tr>
<td>S30403</td>
<td>304L</td>
<td>18-20</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18</td>
</tr>
</tbody>
</table>

2. Location of material fabrication.

D. Fittings for piping 3 inches in nominal diameter and greater:
   1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.
   3. Wall thickness of fitting: In accordance with ASME B36.19 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 ASME B16.11.
      b. Fittings with flanged ends: In accordance with ASME B16.5, Class 150.

E. Fittings for piping less than 3 inches in diameter:
   1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.
   2. Manufacturing standard: In accordance with ASTM A403, Class WP.
   3. Wall thickness and dimensions of fitting: In accordance with ASME B16.11 and as required for the schedule of pipe specified.
   4. End configuration: As needed to comply with specified type of joint.
   5. Forgings in accordance with ASTM A182, or barstock in accordance with ASTM A276. Match forging or barstock material to 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 as specified in Section 15052 Piping Schedule, design and shop-fabricate piping sections utilizing any of the following joint types:
         1) Welded joints.
         2) Flanged joints.
         3) Grooved joints.
      c. Joints at valves and pipe appurtenances:
         1) Provide flanged valves and flanged pipe appurtenances in stainless steel piping systems with flanged ends.
         2) Design and fabricate piping sections to make connections with flanged valves and pipe appurtenances using flanged coupling adapters or flanged joints.
            a) Flexible couplings and flanged coupling adapters: Provide stainless steel construction with materials matching the piping system, and conforming to requirements as specified in Section 15121.
      d. Joints in digester gas, ozone and oxygen piping systems, membrane and reverse osmosis filtration systems:
         1) Aboveground piping: Welded, flanged, or grooved.
         2) Underwater piping: Welded or flanged.
         3) Buried piping: Welded or mechanically restrained.
   2. Joints in piping 2 inches in diameter and smaller: Flanged, grooved, welded, press fit, or screwed with Teflon tape thread lubricant, as scheduled and as specified in Section 15052.
   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.
      d. Mark each weld with a symbol that identifies the welder.
   4. Flanges for Schedule 40S and Schedule 80S pipe:
      a. Provide forged stainless steel (type matching piping system) welding neck flanges or slip-on flanges in accordance with ASME B16.5 Class 150 or 300, as scheduled.
      b. Material: In accordance with ASTM A182.
   5. Grooved joints:
      a. Pressure less than 500 pounds per square inch:
         1) Cut grooves from Schedule 40 or higher.
      b. Heavier schedule pipe sections used for cut groove ends:
         1) Tapered inside diameter to transition from the inside diameter of the lighter schedule pipe.
      c. Butt welds connecting pipes of different schedules that leave an abrupt change in inside diameter are not allowed.
      d. Couplings:
         1) Rigid type, cast from ductile iron, Victaulic Style 07 or Engineer approved equal. High performance coating as specified in Section 09960.
2) Type 316 (Grade CF-8M) stainless steel in accordance with ASTM A351, A 743, and A 744.
   a) Bolts: Stainless steel in accordance with ASTM F593, Group 2, Condition CW.
   b) Nuts: High manganese stainless steel, type B8S in accordance with ASTM A194.
   c) Manufacturers: The following or Engineer approved equal:
      (1) Piedmont Pacific Corporation.
      (2) Victaulic Style 489 Rigid Coupling.

6. Press fit joints:
   a. Pressures less than 500 pounds per square inch:
      1) Fittings:
         a) Victaulic Vic-Press™ 316, ASTM A312 stainless steel housings with ASTM A276 and ASTM A312 outlets and stainless steel plain or grooved ends, Type 316 stainless steel.
         b) Flange adaptors:
            (1) ASNI Class 150, Van Stone type with stainless steel backup flange and Vic-Press™ ends.
            (2) Rated for service up to 275 pounds per square inch gauge. Victaulic Style P566.
         c) Threaded unions shall be Victaulic Style P585, Type 316 stainless steel, with Vic-Press™ ends.
      2) Gaskets:
         a) Gaskets shall be Grade E EPDM rated for services up to 250 degrees Fahrenheit.
      3) Valves:
         a) Provide Victaulic Series P569 stainless steel ball valves with PTFE seats and Vic-Press™ and/or grooved ends.
         b) Rated for services to 400 pounds per square inch (2,750 kilopascals).
         c) Swing-out design to facilitate in-line maintenance: 3 piece.

G. Gaskets:
   1. Ozone and oxygen service: TFE sheet.
   2. Aeration air service: As specified in Section 15052.
   3. All other service applications: EPDM, nitrile, or other materials compatible with the process fluid.

H. Bolts for flanges:
   1. Bolts and nuts: Type 316 stainless steel in accordance with ASTM A193 heavy hex head.
      a. Bolt length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut.
      b. Nuts: In accordance with ASTM A194 heavy hex pattern.

I. Fabrication of pipe sections:
   1. Welding: Weld in accordance with ASME B31.3.
   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. Cleaning (pickling) and passivation:
1. Following shop fabrication of pipe sections, straight spools, fittings, and other piping components, clean (pickle) and passivate fabricated pieces.
2. Clean (pickle) and passivate in accordance with ASTM A380 or A 967.
   a. If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible.
      1) However, these treatments must be followed by inorganic cleaners such as nitric acid/hydrofluoric acid.
   b. Passivation treatments with citric acid are not allowed.
3. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.

2.02 STAINLESS STEEL TUBING

A. General:
1. Stainless steel tubing and all system appurtenances (fittings, valves, etc.) shall be capable of operating at pressures up to 3,500 psi.

B. Stainless steel tubing:
1. Seamless tubing made of Type 316L stainless steel and in accordance with ASTM A269.
2. Wall Thickness:
   a. Tubing sizes 1 inch diameter or smaller: wall thickness not less than 0.065 inch.
   b. Tubing sizes greater than 1 inch diameter: wall thickness adequate for operating pressure of 3500 psi.

C. Fittings: Swage ferrule design:
1. Components made of:
   a. Type 316 stainless steel.
2. Double acting ferrule design, providing both a primary seal and a secondary bearing force.
3. Flare type fittings are not acceptable.
4. Manufacturers: One of the following or Engineer approved equal:
   a. Crawford Fitting Company, Swagelok.
   b. Hoke, Gyrolok.
   c. Parker, CPI.

D. Valves for use with stainless steel tubing:
1. Ball type valves with swage ends to match tubing diameter.
2. Constructed from:
   a. Type 316 stainless steel with TFE seats.
3. Manufacturers: The following or Engineer approved equal:
   a. Crawford Fitting Company, Swagelok.

E. Supports:
1. Provide supports specifically designed to accommodate tubing systems and manufacturers by the tubing manufacturer.
2.03 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 are in accordance with ASTM A778. Supplemental testing is not required.

C. Provide written certification that the fittings as supplied are in accordance with ASTM A774.
   1. Supplementary testing is not required.

D. Thoroughly clean any equipment before use in cleaning or fabrication of stainless steel.

E. Storage: Segregate location of stainless steel piping from fabrication of any other piping materials.

F. Shipment to site:
   1. Protect all flanges and pipe ends by encapsulating in dense foam.
   2. Securely strap all elements to pallets with nylon straps. Use of metallic straps is prohibited.
   3. Cap ends of tube, piping, pipe spools, fittings, and valves with non-metallic plugs.
   4. Load pallets so no tube, piping, pipe spools, fittings, or valves bear the weight of pallets above.
   5. Notify Engineer when deliveries arrive so Engineer may inspect the shipping conditions.
   6. Engineer may reject material due to improper shipping methods or damage during shipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install piping in such a manner as not to impart strain to connected equipment.

B. Install Victaulic Vic-Press™ joint systems in accordance with the manufacturer's latest recommendations. Follow the instructions listed in the latest Victaulic I-P500 assembly manual.
   1. Pipe shall be square cut, plus or minus 0.030 inch, properly deburred and cleaned.
   2. Pipe ends shall be marked at the required location, using a manufacturer-supplied gauge, to ensure full insertion into the coupling or fitting during assembly.
      a. Use a Victaulic PFT-510 series tool with the proper sized jaw for pressing joints.
      b. Tool shall be fitted with the proper size Victaulic jaw for pressing.

C. Slope horizontal lines so that they can be drained completely.

D. Provide valve drains at low points in piping systems.
E. Install eccentric reducers where necessary to facilitate draining of piping system.

F. Provide access for inspection and flushing of piping systems to remove sediment, deposits, and debris.

3.02 FIELD ASSEMBLY OF SHOP-FABRICATED PIPING SECTIONS

A. Join shop-fabricated piping sections together using backing flanges, flexible couplings, flanged coupling adapters, grooved couplings, or flanges.

3.03 FIELD QUALITY CONTROL

A. Test piping to pressure and by method as specified in Section 15052.
   1. If pressure testing is accomplished with water:
      a. Use only potable quality water.
      b. Piping: Thoroughly drained and dried or place immediately into service.

B. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

3.04 PROTECTION

A. Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the Work.
   1. Use handling methods and equipment to prevent damage to the coating, include the use of wide canvas slings and wide padded skids.
   2. Do not use bare cables, chains, hooks, metal bars, or narrow skids.
   3. Store stainless steel piping and fittings away from any other piping or metals. Storage in contact with ground or outside without projection from bad weather is prohibited.
   4. Protect stainless steel piping and fittings from carbon steel projections (when grinding carbon steel assemblies in proximity) and carbon steel contamination (do not contact stainless steel with carbon steel wire brush or other carbon steel tool).

3.05 COMMISSIONING AND PROCESS START-UP REQUIREMENTS

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.
SECTION 15956

PIPING SYSTEMS TESTING

PART 1  GENERAL

1.01  SUMMARY

A. Section includes: Test requirements for piping systems.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01330 - Submittal Procedures.
      b. Section 01410 - Regulatory Requirements.
      c. Section 01500 - Temporary Facilities and Controls.
      d. Section 15052 - Common Work Results for General Piping.

1.02  REFERENCES


B. American Society of Mechanical Engineers (ASME):
   2. B31.3 - Process Piping.

C. Underwriters Laboratories Inc. (UL).

1.03  TESTING REQUIREMENTS

A. General requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 15052; are specified in the specifications covering the various types of piping; and are specified in this Section.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the plumbing code, as specified in Section 01410, and UL requirements.
4. Test natural gas or digester gas piping:
   a. For less than 125 pounds per square inch gauge working pressure, test in accordance with mechanical code, as specified in Section 01410, or the National Fuel Gas Code, whichever is more stringent.
   b. For 125 pounds per square inch gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.

5. When testing with water, the specified test pressure is considered to be the pressure at the lowest point of the piping section under test.
   a. Lower test pressure as necessary (based on elevation) if testing is performed at higher point of the pipe section.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for testing, cleaning, and disinfecting:
   1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01500.

D. Pipes to be tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test completion: Drain and leave piping clean after successful testing.

G. Test water disposal: Dispose of testing water may be disposed of by discharging into the treatment process at a convenient location at the headworks or alternate location with written Owner approval.

1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Schedule and notification of tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of readiness to test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping.
   3. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.
B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

D. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 TESTING ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and grade:
   1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
   2. 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:
   1. Pull a mandrel through the clean piping section under test.
   2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
   3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within 1 percent plus or minus.
   4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.02 AIR TESTING METHOD FOR PRESSURE PIPING

A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.

B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
   1. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 15052:
   1. Provide temporary pressure relief valve for piping under test:
      a. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ASME B31.1, ASME B31.3, ASE B31.8, or the pipe manufacturer’s stated maximum working pressure.
3. Gradually increase test pressure to an initial test pressure equal to the lesser of 1/2 the test pressure or 25 pounds per square inch gauge.
4. Perform initial check of joints and fittings for leakage.
5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage at each step increase until test pressure reached.
6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.03 TESTING GRAVITY FLOW PIPING

A. Test gravity flow piping indicated with "GR" in the Piping Schedule, as follows:
   1. Unless specified otherwise, subject gravity flow piping to the following tests:
      a. Alignment and grade.
      b. For plastic piping test for deflection.
      c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
   2. Inspect piping for visible leaks before backfilling.
   3. Provide temporary restraints when needed to prevent movement of piping.
   4. Pressure test piping with maximum leakage allowance after backfilling.
   5. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours:
      a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
      b. 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.
      c. 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) For polyvinyl chloride (PVC) gravity sewer pipe: 25 gallons per day per inch diameter per mile of piping under test:
            a) Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:
               (1) For concrete piping with rubber gasket joints: 80 gallons per day per inch of diameter per mile of piping under test:
                  (a) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
               (2) For vitrified clay piping: 500 gallons per day per inch of diameter per mile of piping under test.
               (3) For other piping: 80 gallons per day per inch diameter per mile of piping under test.
3.04 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping Schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment, or piping specialties in test sections if test pressure exceeds the valve, equipment, or piping specialty safe test pressure allowed by the item's manufacturer.
   4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
   5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
   6. When test results indicate failure of selected sections, limit tests to piping:
      a. Between valves.
      b. Between a valve and the end of the piping.
      c. Less than 500 feet long.
   7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing procedures:
   1. Fill piping section under test slowly with water while venting air:
      a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
   3. Raise pressure to the specified test pressure and inspect piping visually for leaks:
      a. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
   1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
   2. Pressure test piping after completion of visible leaks test.
   3. For piping systems using joint designs other than flanged, threaded, or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
      b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
c. When leakage is allowed, calculate the allowable leakage by the following formula:

\[ L = S \times D \times P^{1/2} \times 133,200^{-1} \]

wherein the terms shall mean:

L = Allowable leakage in gallons per hour.
S = Length of the test section in feet.
D = Nominal diameter of the piping in inches.
P = Average observed test pressure in pounds per square inches gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

x = The multiplication symbol.

### 3.05 TESTING LOW-HEAD PRESSURE PIPING

**A.** Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.

**B.** General:
1. Test pressures shall be as scheduled in Section 15052.
2. 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.
3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
4. 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:
1. Subject piping under test to the specified pressure measured at the lowest end.
2. Fill piping section under test slowly with water while venting air:
   a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

**D.** Pressure test with maximum leakage allowance:
1. Pressure test piping after completion of visible leaks test.
2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
   a. 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 after 24 hours, and no
damage to piping and appurtenances has occurred.

b. 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.

E. Optional joint test:
1. When joint testing is allowed by note in the Piping Schedule, the procedure
shall be as follows:
   a. Joint testing will be allowed only for low head pressure piping.
   b. Joint testing does not replace and is not in lieu of any testing of the piping
system or trust restraints.
2. Joint testing may be performed with water or air.
3. Joint test piping after completion of backfill and compaction to the top of the
trench.
4. Joint testing with water:
   a. Measure test pressure at the invert of the pipe. Apply pressure of 4 feet
   plus the inside diameter of the pipe in water column within 0.20 foot in
   water column.
   b. Maintain test pressure for 1 minute.
   c. Base the allowable leakage per joint on 80 gallons per inch nominal
diameter, per mile of piping, per 24 hours equally distributed to the actual
number of joints per mile for the type of piping.
   d. Consider the pressure test to be complete when makeup water added is
less than the allowable leakage.
   e. Successful completion of the joint test with water shall have been
achieved when the observed leakage is equal or less than the allowable
leakage.
5. Joint testing with air:
   a. Apply test pressure of 3 pounds per square inch gauge with a maximum
variation of plus 0.20 and minus 0.00 pounds per square inch.
   b. Maintain test pressure for 2 minutes.
   c. Consider the pressure test to be complete when the test pressure does
not drop below 2.7 pounds per square inch for the duration of the test.

END OF SECTION
SECTION 15958
MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Testing of mechanical equipment and systems.

B. Related sections:
   2. Section 15956 - Piping Systems Testing.
   3. Section 16222 - Low Voltage Motors up to 500 Horsepower.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. S1.4 Specification for Sound Level Meters.

B. Hydraulic Institute (HI).

C. National Institute of Standards and Technology (NIST).

1.03 SUBMITTALS

A. Schedule of source (factory) tests, Owner training, installation testing, functional testing, clean water facility testing, closeout documentation, process start-up and process operational period as specified in this Section and in Section 01756 and equipment sections.

B. Test instrumentation calibration data:

C. Operation and maintenance manual:
   1. Include motor rotor bar pass frequencies for motors larger than 500 horsepower.

D. Commissioning and Process Start-up Plan: As specified in Section 01756.

E. Test plan as specified in Section 01756 and equipment sections.

F. Test reports as specified in this Section and in Section 01756 and equipment sections.

PART 2 PRODUCTS

Not Used.
PART 3  EXECUTION

3.01  GENERAL

A. Commissioning and process start-up of equipment as specified in:
   1. This Section.
   2. Section 01756.
   3. Equipment sections.
      a. If testing requirements are not specified, provide Level 1 Tests.

B. Comply with latest version of applicable standards.

C. Test and prepare piping as specified in Section 15956.

D. Operation of related existing equipment: Owner will operate related existing
   equipment or facilities necessary to accomplish the testing. Schedule and
   coordinate testing as required by Section 01756.

E. Provide necessary test instrumentation that has been calibrated within 1 year from
   date of test to recognized test standards traceable to the NIST or approved source.
   1. Properly calibrated field instrumentation permanently installed as a part of the
      Work may be utilized for tests.
   2. Prior to testing, provide signed and dated certificates of calibration for test
      instrumentation and equipment.

F. Test measurement and result accuracy:
   1. Use test instruments with accuracies as recommended in the appropriate
      referenced standards. When no accuracy is recommended in the referenced
      standard, use 1 percent or better accuracy test instruments.
      a. Improved (lower error tolerance) accuracies specified elsewhere prevail
         over this general requirement.
   2. Do not adjust results of tests for instrumentation accuracy.
      a. Measured values and values directly calculated from measured values
         shall be the basis for comparing actual equipment performance to
         specified requirements.

G. Report features:
   1. Report results in a bound document in generally accepted engineering format
      with title page, written summary of results compared to specified requirements,
      and appropriate curves or plots of significant variables in English units.
   2. Include appendix with a copy of raw, unmodified test data sheets indicating
      test value, date and time of reading, and initials of person taking the data.
   3. Include appendix with sample calculations for adjustments to raw test data and
      for calculated results.
   4. Include appendix with the make, model, and last calibration date of
      instrumentation used for test measurements.
   5. Include in body of report a drawing or sketch of the test system layout showing
      location and orientation of the test instruments relative to the tested equipment
      features.
H. Provide necessary fluids, utilities, temporary piping, temporary supports, temporary access platforms or access means and other temporary facilities and labor necessary to safely operate the equipment and accomplish the specified testing.
1. With Owner’s permission, some utilities may be provided by fully tested permanently installed utilities that are part of the Work.

I. Prepare and submit test reports as specified.

J. Testing levels:
1. Level 1 Tests:
   a. Level 1 General Equipment Performance Test:
      1) For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
      2) Operate at rated design load conditions.
      3) Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
   b. Level 1 Pump Performance Test:
      1) Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
      2) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222 or the applicable equipment section. Use actual driver for field tests.
      3) Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
   c. Level 1 Vibration Test:
      1) Test requirement:
         a) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
         b) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
      2) Equipment operating condition: Test at specified maximum speed.
   d. Level 1 Noise Test:
      1) Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

2. Level 2 Tests:
   a. Level 2 General Performance Test:
      1) For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
      2) Operate at rated design load conditions.
3) Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

b. Level 2 Pump Performance Test:
1) Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
2) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222. Use actual driver for field tests.
3) Test for flow and head at 2 additional conditions; 1 at 25 percent below the rated flow and 1 at 10 percent above the rated flow.
4) Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.

c. Level 2 Vibration Test:
1) Test requirement:
   a) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
   b) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
2) Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
3) Natural frequency test of field installed equipment:
   a) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears, and supports.
   b) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.
   c) Perform with equipment and attached piping full of intended service or process fluid.

d. Level 2 Noise Test:
1) Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.
3. Level 3 Tests:
   a. Level 3 General Equipment Performance Tests:
      1) For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
      2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
      3) Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration, or temperatures are observed.
      4) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure, and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
      5) Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.
   b. Level 3 Pump Performance Test:
      1) Test 4 hours minimum for flow and head at or near the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
      2) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222. Use actual driver for field tests.
      3) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes; for factory testing, test at other speeds may be omitted if test driver at reduced speeds is used for rated condition testing.
      4) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.
   c. Level 3 Vibration Test:
      1) Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
      2) Perform High Frequency Enveloping Analysis for gears and bearings.
         a) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
         b) Report results in units of acceleration versus frequency in cycles per minute.
      3) Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).
4) Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.

d. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plan view; report results for each of 8 octave band mid-points beginning at 63 hertz.

4. Level 4 Tests:
   a. Level 4 General Equipment Performance Test:
      1) For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.
      2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
      3) Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration, or temperatures are observed.
      4) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure, and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
      5) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

   b. Level 4 Pump Performance Test:
      1) Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
      2) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration, and noise data at each test condition.
      3) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.
      4) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
      5) Perform efficiency and/or net positive suction head required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
         a) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
b) Perform efficiency testing with test fluids at maximum rated speed.
c) Perform priming time testing with test fluids at maximum rated speed.
c. Level 4 Vibration Test: Same as Level 3 vibration test.
d. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

K. Variable speed equipment tests:
   1. Establish performance over the entire speed range and at the average operating condition.
   2. Establish performance curves for the following speeds:
      a. The speed corresponding to the rated maximum capacity.
      b. The speed corresponding to the minimum capacity.
      c. The speed corresponding to the average operating conditions.

L. Pump tests, all levels of testing:
   1. Test in accordance with the following:
      a. Applicable HI Standards.
      b. This Section.
      c. Equipment sections.
   2. Test tolerances: In accordance with appropriate HI Standards, except the following modified tolerances apply:
      a. From 0 to plus 5 percent of head at the specified flows.
      b. From 0 to plus 5 percent of flow at the rated design point head.
      c. No negative tolerance for the efficiency at the specified flows.
      d. No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits, and methods specified in this or other Sections of the Specifications.

M. Drivers tests:
   1. Test motors as specified in Section 16222.
   2. Test other drivers as specified in the equipment section.

N. Noise requirements and control:
   1. Perform noise tests in conjunction with vibration test analysis.
   2. Make measurements in relation to reference pressure of 0.0002 microbar.
   3. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.
   4. Set sound level meter to slow response.
   5. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

O. Pressure testing:
   1. Hydrostatically pressure test pressure containing parts at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher.

P. Inspection and balancing:
   1. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits.
2. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.

3. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

Q. Critical speed of rotating equipment:
   1. Satisfy the following:
      a. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment's maximum operating speed.
      b. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
      c. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.

R. Vibration tests:
   1. Definitions:
      a. Root mean square: for pumps operating at speeds greater than 600 rpm, the vibration measurement shall be measured as the overall velocity in inches per second root mean square (RMS).
      b. Peak-to-peak displacement: The root mean squared average of the peak-to-peak displacement multiplied by the square root of 2.
      c. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
      d. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
      e. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency.
         1) Manufacturers: One of the following or Engineer approved equal:
            b) CSI, "PeakVue."
      f. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
      g. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.
      h. Preferred operating range: Manufacturer's defined preferred operating range (POR) for the equipment.
      i. Allowable operating range: Manufacturer's defined allowable operating range (AOR) for the equipment.
   2. Vibration instrumentation requirements:
      a. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12 bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles.
per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, data output port, circuitry for integration of acceleration data to velocity or double integration to displacement.

1) Manufacturers: One of the following or Engineer approved equal:
   b) Pruftechnik, VIBXPERT II.

b. Analyzer settings:
   1) Units: English, inches/second, mils, and gravitational forces.
   2) Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
   3) Sample averages: 4 minimum.
   4) Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
   5) Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
   6) Fast fourier transform windowing: Hanning Window.
   7) High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.

c. Accelerometers:
   1) For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount.
      a) Manufacturers: One of the following or Engineer approved equal:
         (1) Wilcoxon Research, Model 797L.
         (2) PCB, Model 393C.
   2) For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3 dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder.
      a) Manufacturers: One of the following or Engineer approved equal:
         (1) Wilcoxon Research, Model 793.
         (2) Entek-IRD Model 943.

3. Accelerometer mounting:
   a. Use magnetic mounting or stud mounting.
   b. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
   c. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.
4. Vibration acceptance criteria:
   a. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.
   b. Vibration displacement limits: Unless otherwise specified, equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

<table>
<thead>
<tr>
<th>Operating Conditions &amp; Application Data</th>
<th>Overall Peak-to-Peak Displacement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Field, mils</td>
</tr>
<tr>
<td>Operation within the POR</td>
<td>3.0</td>
</tr>
<tr>
<td>Operation within the AOR</td>
<td>4.0</td>
</tr>
<tr>
<td>Additive value when measurement location is greater than 5 feet above foundation.</td>
<td>2.0</td>
</tr>
<tr>
<td>Additive value for solids-handling pumps</td>
<td>2.0</td>
</tr>
<tr>
<td>Additive value for slurry pumps</td>
<td>2.0</td>
</tr>
</tbody>
</table>

c. Vibration velocity limits: Unless otherwise specified, equipment operating at speeds greater than 600 revolutions per minute is not to exceed the following peak velocity limits:

<table>
<thead>
<tr>
<th>HI Pump Type</th>
<th>Horsepower</th>
<th>Field Test</th>
<th>Factory Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motors</td>
<td>All</td>
<td>Overall RMS</td>
<td>See Applicable Motor Specification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overall RMS</td>
<td>See Applicable Motor Specification</td>
</tr>
</tbody>
</table>

d. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.

e. Additional criteria:
   1) No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.
   2) The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.
   3) For motors, the following shall be cause for rejection:
      a) Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that are more than 40 percent of the peak at rotational frequency.
      b) Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.
      c) Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.
d) Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.

4) The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

5. Vibration testing results presentation:
   a. Provide equipment drawing with location and orientation of measurement points indicated.
   b. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
   c. When Vibration Spectra Data required:
      1) Plot peak vibration velocity versus frequency in cycles per minute.
      2) Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
      3) Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
      4) Plot motor spectra on a log amplitude scale versus frequency.
   d. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
   e. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.02 PLANNING PHASE

A. Submit test plans as specified in Section 01756 and this Section.
   1. Indicate test start time and duration, equipment to be tested, other equipment involved or required; temporary facilities required, number and skill or trade of personnel involved; safety issues and planned safety contingencies; anticipated effect on Owner's existing equipment and other information relevant to the test.
   2. Provide locations of all instruments to be used for testing. Provide calibration records for all instrumentation.

3.03 COMMISSIONING PHASE

A. Source testing:
   1. Witnessing not required unless specified otherwise in equipment section.
   2. Witnessed tests: Schedule test date and notify Engineer at least 30 days prior to start of test.
   3. Test equipment as specified in Section 01756 and equipment sections.
   4. Test fluids as specified in Section 01756.
   5. Submit reports as specified in Section 01756.
B. Installation testing:
   1. Test equipment as specified in Section 01756 and equipment sections.

C. Functional testing:
   1. Witnessing required as specified in Section 01756.
   2. Schedule test date and notify Engineer at least 7 days prior to start of test.
   3. Test equipment as specified in equipment sections. Test fluids as specified in Section 01756.
   4. Submit reports as specified in Section 01756.

D. Clean Water Facility Testing:
   1. Test equipment as specified in Section 01756 and equipment sections.

E. Closeout documentation:
   1. Provide closeout documentation as specified in Section 01756 and equipment sections.

3.04 PROCESS START-UP PHASE

A. Process start-up:
   1. Process start-up equipment as specified in Section 01756 and equipment sections.

B. Process Operational Period:
   1. Operate equipment as specified in Section 01756 and equipment sections.
   2. Test fluids as specified in Section 01756.

END OF SECTION
SECTION 16222
LOW VOLTAGE MOTORS UP TO 500 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage motors up to 500 horsepower.

B. Related sections:
   1. Section 01610 - Project Design Criteria.
   2. Section 01756 - Commissioning.
   3. Section 15050 - Common Work Results for Mechanical Equipment.
   4. Section 16950 - Field Electrical Acceptance Tests.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Petroleum Institute (API):

C. ASTM International (ASTM).

D. Institute of Electrical and Electronic Engineers (IEEE):
   1. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   2. 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
   4. 303 - Recommended Practice for Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations.
   5. 841 - Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).

E. National Electrical Manufacturers' Association (NEMA):
   1. MG-1 - Motors and Generators.

F. Underwriters Laboratories Inc. (UL):
   1. 674 - Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
1.03 DEFINITIONS (NOT USED)

1.04 SYSTEM DESCRIPTION

A. Furnish and install electric motors and accessories as specified in this Section and
the Sections specifying driven equipment to provide a complete and operable
installation.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 15050.

B. Submit completed motor data sheets for each motor supplied:
   1. Conform to data sheet in the appendix of this Section.
   2. Manufacturer’s or other data sheets are not acceptable.

C. Product data:
   1. Descriptive bulletins.
   2. Machine tag and loop number as indicated on the Drawings and in the
      specification section number of the driven machine.
   3. Complete electrical data.
   4. Torque, current, and power factor vs. speed curves:
      a. At 100 percent rated voltage for all full voltage started and VFD driven
         motors.
      b. For motors on reduced voltage start at 70, 80, 90, and 100 percent rated
         voltage.
   5. Accessories data:
      a. Power factor correction capacitors:
         1) Size in kVAR, for all motors not connected to variable frequency
            drives.
      b. Motor winding heaters:
         1) Voltage.
         2) Watts.
      c. Winding temperature detectors:
         1) Type.
         2) Rating.
      d. Moisture detectors.
   6. Mechanical data:
      a. Bearing design and bearing life calculations.
      b. Resonant frequencies for all VFD-driven motors 50 horsepower or
greater.

D. Shop drawings:
   1. Motor weight.
   2. Frame size.
   3. Conduit box(es), size(s), and location(s).
   4. Outline drawings with dimensions.
   5. Installation details for the project seismic criteria.

E. Test reports:
   1. Factory test reports with test reference standard identified.
F. Certification:
   1. When motors are driven by variable speed drive systems, submit certification
      that selected motor:
      a. Is capable of satisfactory performance under the intended load.
      b. Meets the requirements of the latest edition of NEMA MG-1 Part 31.

G. Calculations:
   1. Where site conditions specified in Section 01610 exceed manufacturer's
      ratings, provide derating calculations for each motor.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS
   A. As specified in Section 01610.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY
   A. Provide a Manufacturer's warranty meeting the requirement of General Conditions.

1.12 SYSTEM START-UP
   A. As specified in Section 01756.

1.13 OWNER'S INSTRUCTION (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. One of the following or equal:
      1. US Motors.
      2. General Electric.
      3. Reliance.
      4. Toshiba.
      5. Baldor.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)
2.05 EQUIPMENT

A. 3-phase induction motors - general:
   1. Voltage:
      a. All motors 1/2 hp and larger shall be rated 460 V, 3 phase unless otherwise indicated on the Drawings.
      b. Dual voltage motors rated 230/460 V, 3 phase are acceptable provided all leads are brought to the conduit box.
   2. Motors driving identical machines shall be identical.
   3. All motors greater than 1 hp and up to 500 hp shall meet the "NEMA Premium Efficiency" percent listed in NEMA MG-1.
   4. Horsepower as indicated on the Drawings:
      a. Horsepower ratings indicated on the Drawings are based on vendor's estimates. Provide motors sized for the load of the actual equipment furnished without operating in the service factor.
   5. Service factor:
      a. 1.15 service factor on sine wave power.
      b. 1.0 when driven by VFD.
   6. Torque:
      a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
      b. When started using reduced voltage starters:
         1) Provide motors that develop sufficient torque for acceleration to full speed.
      c. NEMA Design B except where driven load characteristics require other than normal starting torque:
         1) In no case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
   7. Enclosures:
      a. As specified in the individual equipment Specifications or in this Section.
      b. Totally enclosed fan cooled:
         1) Cast iron conduit box.
         2) Tapped drain holes with Type 316 stainless steel plugs for frames 286 and smaller, and automatic breather and drain devices for frames 324 and larger.
      c. Lifting devices: All motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
   8. Manufactured with cast iron frames in accordance with NEMA MG-1 or manufacturer's standard material for the specified rating.
   9. Nameplates:
      a. Provide all motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
         1) NEMA standard motor data.
         a) Indicate compliance with NEMA MG-1 Part 31 for inverter duty motors.
         2) AFBMA bearing numbers and lubrication instructions.
   10. Hardware:
       a. Type 316 stainless steel.
   11. Conduit boxes:
       a. Cast iron or stamped steel.
       b. Split from top to bottom.
c. Provide gaskets at the following interfaces:
   1) Frames and conduit boxes.
   2) Conduit boxes and box covers.

d. Rotatable through 360 degrees in 90-degree increments.
   1) Where available based on the size of the conduit box.

e. Exceeding the dimensions defined in NEMA MG-1.

f. Provide grounding lugs inside conduit boxes for motor frame grounding.

12. Motor bearings:
   a. Antifriction.
   b. Regreasable and initially filled with grease for horizontal motors, vertical
      motors per manufacturer's standard design.
   c. Bearings and lubrication suitable for ambient temperature and
      temperature rise.
   d. Suitable for intended application and have ABMA L-10 rating life of
      60,000 hours or more.
   e. Fit bearings with easily accessible grease supply, flush, drain, and relief
      fittings using extension tubes where necessary.
   f. Where specified in the equipment Specifications, provide split-sleeve type
      hydrodynamic radial bearings. Provide a bearing isolator to protect
      bearings from contaminants.

13. Insulation systems:
   a. Motors installed in ambient temperatures 40 degrees Celsius or less:
      1) Provide Class F insulation.
      2) Design temperature rise consistent with Class B insulation.
      3) Rated to operate at an ambient temperature of 40 degrees Celsius at
         the altitude where the motor will be installed.
   b. Motors installed in ambient temperatures between 40 degrees Celsius
      and 50 degrees Celsius:
      1) Provide Class F insulation.
      2) Design temperature rise consistent with Class B insulation.
      3) Rated to operate at an ambient temperature of 50 degrees Celsius at
         the altitude where the motor will be installed.
   c. Motors installed in ambient temperatures between 50 degrees Celsius
      and 65 degrees Celsius:
      1) Provide Class H insulation.
      2) Design temperature rise consistent with Class F insulation.
      3) Rated to operate at an ambient temperature of 65 degrees Celsius at
         the altitude where the motors will be installed.

14. Motor leads:
   a. Insulated leads with non-wicking, non-hydroscopic material. Class F
      insulation.

15. Noise:
   a. Maximum operating noise level in accordance with NEMA MG-1.

B. Motors driven by variable frequency drives:
   1. Compatible with the variable frequency drives specified.
   2. Inverter duty rated and labeled.
   3. Meet the requirements of NEMA MG-1 Part 31.
   4. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
   5. Capable of running continuously at 1/10th of full speed, with no harmful effects
      or overheating.
6. Shaft grounding ring:
   a. Provide a shaft grounding ring for each VFD driven motor.
   b. Aluminum frame and internal components.
   c. Conductive microfiber brushes.
   d. Maintenance free design.
   e. Aegis Bearing Protection ring as manufactured by Electro Static Technology or equal.

7. On motors over 100 hp, provide insulated bearings on bearings on both ends of the motor or on the end opposite of the shaft ground ring as recommended by the motor manufacturer.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Motor winding heaters:
   1. Provide all 3 phase motors with belted or cartridge space heaters mounted within the motor enclosure.
   2. Space heater rating shall be 120 volts, single-phase, unless otherwise indicated on the Drawings.
   3. Power leads for heaters wired into conduit box.
   4. Installed within motor enclosure adjacent to core iron.

B. Winding temperature detectors:
   1. Temperature switches with normally closed contacts as indicated on the Drawings.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

   A. Install motors in accordance with manufacturer's instructions.

   B. Install shaft grounding ring on VFD driven motors in accordance with the manufacturer's instructions.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)
3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING AND PROCESS START-UP

A. As specified in Section 01756.

B. Factory testing:
   1. Motors less than 250 horsepower:
      a. Perform manufacturer's standard production tests including but not limited to:
         1) No load current.
         2) High potential test.
         3) Winding resistance.
      b. Furnish copies of standard test reports on prototype or identical units.

3.08 FIELD QUALITY CONTROL

A. Before start-up, perform insulation resistance test on each motor furnished or installed on this project:
   1. Windings energized to 1,000 volts DC for 1 minute.
   2. Resistance measured at the end of the test, recorded, and submitted to the Engineer for review.
   3. Inform the Engineer of any unusual or unacceptable test results.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

END OF SECTION
# MOTOR DATA SHEET

**MOTOR/ EQUIPMENT TAG** __________________________  **MOTOR NUMBER** __________________________

**SPECIFICATION NUMBER OF DRIVEN MACHINE** __________________________________________

## MOTOR NAMEPLATE DATA

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>MODEL/SERIES</th>
<th>MODEL NO.</th>
<th>FRAME</th>
<th>ENCLOSURE</th>
<th>NEMA DESIGN</th>
<th>HP</th>
<th>SERVICE FACTOR</th>
<th>RPM</th>
<th>INSULATION CLASS</th>
<th>VOLTS</th>
<th>FULL LOAD AMPS</th>
<th>AMBIENT TEMP</th>
<th>PHASE</th>
<th>NO LOAD AMPS</th>
<th>DESIGN TEMP</th>
<th>HERTZ</th>
<th>LOCK ROTOR AMPS</th>
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**GUARANTEED MINIMUM EFFICIENCIES:**                       

**GUARANTEED MINIMUM POWER FACTOR:**                        

**MAXIMUM SIZE OF POWER FACTOR CORRECTION CAPACITOR:**     

## ACCESSORIES

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<tr>
<th>MOTOR WINDING HEATER</th>
<th>VOLTS</th>
<th>WATTS</th>
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**WINDING THERMAL PROTECTION**

**WINDING TEMP SWITCHES (YES/NO)** __________________________

**RTD:**

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<th>TYPE</th>
<th>QUANTITY PER PHASE</th>
<th># OF WIRES</th>
<th>NOMINAL RESISTANCE</th>
<th>NOMINAL TEMP</th>
<th>COEFFICIENT</th>
<th>RECOMMENDED ALARM</th>
<th>DEGREES CELSIUS</th>
<th>RECOMMENDED TRIP</th>
<th>DEGREES CELSIUS</th>
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**RECOMMENDED**

**SPECIAL APPLICATIONS**

<table>
<thead>
<tr>
<th>INVERTER DUTY* (YES/NO)</th>
<th>PART WINDING (YES/NO)</th>
<th>WYE - DELTA (YES/NO)</th>
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<table>
<thead>
<tr>
<th>2 SPEED, 1 WINDING (YES/NO)</th>
<th>2 SPEED, 2 WINDING (YES/NO)</th>
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**AREA CLASSIFICATION:**

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<th>CLASS</th>
<th>DIVISION</th>
<th>GROUP</th>
<th>TEMP CODE</th>
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* Conforms to NEMA MG-1 Part 31.
SECTION 16262
VARIABLE FREQUENCY DRIVES 0.50 – 50 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Variable frequency drives (VFD) 0.5 to 50 horsepower for control of NEMA Design B squirrel cage induction motors.

B. Related sections:
   1. Section 01756 - Commissioning.
   2. Section 15050 - Common Work Results for Mechanical Equipment.
   3. Section 16222 - Low Voltage Motors Up To 500 Horsepower.

1.02 REFERENCES

A. As specified in Section 16050.

B. International Organization for Standardization (ISO):
   1. 9001 - Quality Management Systems - Requirements.

C. National Electrical Manufacturers Association (NEMA):
   1. MGI, Part 31 – Motors with higher peak voltage capability.

D. Underwriters' Laboratories (UL):
   2. 508C - Standard for Power Conversion Equipment.

1.03 DEFINITIONS

A. Specific definitions:
   1. Point of common coupling: the point of common coupling for all harmonic calculation and field measurements for both voltage and current distortions is defined as the closest directly connected bus supplying power to the VFD.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Each VFD system consists of all components required to meet the performance, protection, safety, testing, and certification criteria of this Section.
   2. The VFD system:
      a. Is a fully integrated package.
      b. Includes all material necessary to interconnect all VFD system elements, even if shipped separately.
   3. Coordinate bearing protection methods with the supplier of the driven equipment.
B. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer:
   1. Each VFD shall be completely factory pre-wired, assembled, and then tested as a complete system by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.
   2. The VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics based upon the installed conditions:
      a. Provide equipment necessary to mitigate potential damage to motor insulation.
      b. Motors as specified in Section 16222.

C. Performance:
   1. Operating envelope:
      a. Speed and torque requirements:
         1) Provide a variable torque or constant torque VFD as required by the driven load.
         2) The VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 200 percent (25 to 120 hertz) speed range.
      b. Current requirements:
         1) Full rated current output on a continuous basis.
         2) Variable torque VFD:
            a) Minimum 110 percent current overload for 1 minute.
         3) Constant torque VFD:
            a) Minimum 150 percent current overload for 1 minute.
   2. Minimum VFD system efficiency:
      a. Ninety-six percent when operating at the rated kW output.
      b. VFD system efficiency shall be calculated as follows:

         Efficiency (%) = \( \frac{\text{Power (Load)}}{\text{Power (Supply)}} \times 100 \)

         Power (Load) is the total power measured at the output terminals of the drive system, including VFD, output filters or transformers. Power (Supply) is the total power measured at the input terminals of the VFD including input filters, line reactors, isolation transformers, harmonic distortion attenuation equipment and auxiliary equipment (e.g., controls, fans) for complete system operation.
   3. Total power factor:
      a. Minimum of 0.96 lagging across the entire speed range.
      b. At no speed shall the VFD have a leading power factor.
   4. Frequency accuracy:
      a. Minimum of within 0.01 percent.
   5. Speed regulation:
      a. Minimum of within 0.5 percent across the entire speed range.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 15050:
   1. Custom prepared by the VFD manufacturer and specific for the equipment furnished.
B. Product data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
      d. Weight.
   4. Nameplate schedule.
   5. Bill of material.
   6. Ratings:
      a. Voltage.
      b. Phase.
      c. Input current.
      d. Output current.
      e. Interrupting rating.
      f. Momentary current rating.
   7. List of recommended spare parts.
   8. Catalog cut sheets for major components.
   9. Design data:
      a. Efficiency and power factor values.
      b. Certification that the drive is sized for the full nameplate motor horsepower and current of the driven load at the installed altitude and ambient temperature.
      c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
      d. Certification that all electronic circuits and printed circuit boards are conformally coated.

C. Shop drawings:
   1. Complete plan and elevation drawings showing:
      a. All dimensions.
      b. Panel, sub-panel and component layout indexed to the bill of material.
      c. Conduit connections.
   2. Block diagram showing the basic control and protection systems specifying the protection, control, trip and alarm functions, the reference signals and commands and the auxiliary devices.
   3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
      a. Include terminal number and wire numbers.
   4. Complete single-line and 3-line diagrams including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
      a. Clearly indicate device electrical ratings on the drawings.

D. Operation and maintenance manuals:
   1. Spare parts list with supplier names and part numbers.
   2. Startup and commissioning instructions and data.
3. Operating manuals:
   a. Submit operating instructions and a maintenance manual presenting full
details for care and maintenance of each model of VFD provided under
this Contract.
4. Operating instructions:
   a. Written descriptions detailing the operational functions of all controls on
the front panel.
5. Maintenance manual:
   a. Furnish maintenance manuals with instructions covering all details
pertaining to care and maintenance of all equipment as well as identifying
all parts.
   b. Manuals shall include, but are not limited to the following:
      1) Adjustment and test instructions covering the steps involved in the
initial test, adjustment and start-up procedures.
      2) Detailed control instructions which outline the purpose and operation
of every control device used in normal operation.
      3) All schematic wiring and external diagrams:
         a) Furnish drawings in a reduced 11-inch by 17-inch format that
are fully legible at that size.

E. Test forms and reports.
   1. Submit complete factory acceptance test procedures and all forms used during
the test.

F. Manufacturer's Certificate of Installation and Functionality Compliance.

G. Manufacturer's field reports:
   1. Report listing the setting of all VFD adjustable parameters and their values
after start-up.

H. Record Documents:
   1. Certified Record Documents of equipment with information listed above.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Any third party certification, safety or protection requirements shall be applied
to the VFD system as a whole. Certification or protection of system elements
or individual components by themselves is not acceptable.
   2. VFDs shall be UL 508C listed and labeled:
      a. UL 508A for VFD systems in control panels.
   3. Variable frequency drives shall be manufactured by the VFD manufacturer at
its own facility which shall have a quality assurance program that is certified in
conformance with ISO 9001.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING

A. Conduct factory acceptance test and submit certified test results for Engineer's
review.
B. Ship equipment to project site after successful completion of factory acceptance test.

C. Assemble equipment in the field.

D. Conduct field acceptance test and submit results for Engineer's review.

E. Submit Manufacturer's Installation and Functionality Compliance.

F. Conduct Owner's training sessions.

G. Commissioning and process start-up as specified in Section 01756.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. Provide a Manufacturer's warranty meeting the requirement of General Conditions.

1.12 SYSTEM START-UP

A. The VFD manufacturer shall be responsible for start up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer and Owner.

1.13 OWNERS INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Spare parts:
   1. The following spare parts shall be furnished:
      a. One complete VFD of each size furnished.
      b. One set of all power and control fuses for each VFD.
      c. One complete main control key pad for each type and rated size of VFD.
      d. Any special dedicated tools for emergency service and troubleshooting.
      e. All hardware and software required for configuration, maintenance, troubleshooting and inquiry of all drive parameters.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   4. Schneider Electric/Square D.
   5. General Electric.
   6. ABB.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)
2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. Sinusoidal pulse width modulated (PWM) type drive.
      a. Six-pulse insulated gate bipolar transistor (IGBT) power section.
      b. Microprocessor based controls.
      c. Line and load reactors.

B. Ratings:
   1. Voltage:
      a. Input voltage as indicated on the Drawings.

C. Operational features:
   1. Protective features:
      a. Provide the following minimum protective features:
         1) Motor overload protection.
         2) Instantaneous overcurrent.
         3) Instantaneous overvoltage.
         4) Undervoltage.
         5) Power unit overtemperature.
         6) Phase loss.
         7) VFD output short circuit.
   2. Control mode:
      a. Operation in either a constant volts/hertz or sensorless vector mode:
         1) The control mode selectable using the programming keypad.
   3. Frequency control:
      a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
      b. Programmable minimum frequency.
      c. Programmable maximum frequency.
   4. Acceleration/deceleration:
      a. Separately adjustable acceleration and deceleration rates:
         1) Each rate adjustable from 0.01 to 1,800 seconds.
   5. Spinning load:
      a. The VFD shall be capable of determining the speed and direction of a
         spinning load, "catch" the load and accelerate or decelerate it without
         damage to the load.
   6. Programmable loss of signal:
      a. Upon loss of speed reference the VFD shall be programmable to either:
         1) Stop.
         2) Maintain current speed.
         3) Default to pre-selected speed.
   7. Power interrupt ride-through:
      a. The VFD shall be capable of continuous operation in the event of a power
         loss of 5 cycles or less.
   8. Inputs/Outputs:
      a. Manufacturer's standard number the following:
         1) Analog inputs:
            a) Configurable as either 0 to 10 volts or 4 to 20 milliamperes.
         2) Analog outputs:
            a) Programmable 4 to 20 milliamperes isolated.
3) Discrete inputs:
   a) Programmable.
4) Discrete outputs:
   a) Programmable.
   b) Form C relay contacts.
5) Potentiometer 3-wire input.

b. Provide additional inputs/outputs as required to meet the control functions of the control panels.

9. Diagnostics:
   a. Store a minimum of 4 fault conditions in non-volatile memory on a first in-first out basis.
   b. Operational parameters stored at the time of a the fault:
      1) Operating frequency.
      2) Drive status.
      3) Power mode.
   c. Fault memory accessible via RS-232, RS-422 or RS-485.

10. Automatic restart:
   a. User selectable automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
      1) Programmable for up to 9 restart attempts.
      2) Adjustable time delay between restart attempts.

2.06 COMPONENTS

A. Enclosure:
   1. Control Panel.
   2. Provide cooling devices required to maintain the VFD within the manufacturer's specified temperature limits for the Project conditions:
      a. Provide cooling device failure alarm.

B. Power disconnect:
   1. Motor circuit protector, MCP.

C. Reactors:
   1. Line reactors: 3 percent input and 3 percent output.

D. Keypad:
   1. Provide each VFD with a keypad for programming and control.
   2. Keypad requirements:
      a. Password security to protect drive parameters.
      b. Mounted on the VFD.
      c. Back-lit LCD:
         1) Minimum of 2 lines with a minimum of 16 characters per line.
      d. Programming and display features language: English.
      e. Capable of displaying the following parameters:
         1) Speed (percent).
         2) Output current (amperes).
         3) Output frequency (hertz).
         4) Input voltage.
         5) Output voltage.
         6) Total 3-phase kilowatt.
         7) Kilowatt-hour meter.
8) Elapsed run time meter.
9) Revolutions per minute.
10) Direct current bus voltage.

3. In addition to all keys required for programming, provide the following controls on the keypad:
   b. Start pushbutton.
   c. Stop pushbutton.
   d. Jog pushbutton.
   e. Speed increment.
   f. Speed decrement.
   g. Forward/reverse selector.
   h. Run LED indicator.
   i. Program LED indicator.
   j. Fault LED indicator.

1) Provide the VFD with the hardwired controls as indicated on the Drawings.

E. Control power transformer:
   1. Furnish a control power transformer mounted and wired inside the VFD enclosure.
   2. With primary and secondary fusing.

2.07 ACCESSORIES

A. Metal oxide varistors:
   1. Provide protection for the VFD against:
      a. Line transients: 5,000 volt peak minimum.
      b. Line to ground transients: 7,000 peak minimum.

B. Conformal coating:
   1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as a protection against moisture, dust, temperature extremes, and chemicals such as H₂S and chlorine.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Enclosure finish shall be manufacturer's standard gray.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)
3.03 INSTALLATION

A. General:
   1. Provide openings in top or bottom of the VFD (control panel) enclosure for conduit only, no additional openings will be allowed:
      a. Improperly cut holes will require that the entire panel be replaced:
         1) No hole closers or patches will be allowed.
   2. Bundle circuits together and terminate in each unit:
      a. Tie with nylon wire ties.
      b. Label all wires at each end with wire numbers shown on the approved control drawings.
      c. All connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

B. Source testing (Factory Acceptance Tests):
   1. General:
      a. Incoming inspection of components and raw materials based on strategic supplier base and experience.
      b. All VFDs furnished under this Section shall be tested and inspected as specified below. Testing of VFDs based on sampling plans is not allowed.
      c. The testing procedures specified are the minimum acceptable requirements. The manufacturer may perform additional tests at its discretion.
   2. Failure of any component during testing requires repair of the faulted component and complete retest.
   3. Tests:
      a. Perform manufacturer's standard factory acceptance tests.

C. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

D. Owner training:
   1. As specified in Sections 01756.

3.08 FIELD QUALITY CONTROL

A. Provide the services of a VFD manufacturer representative for startup assistance and training:
   1. Inspection and field adjustment:
      a. Supervise the following and submit written certification that the equipment and controls have been properly installed, aligned, adjusted, and readied for operation.
2. Startup field testing:
   a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
   b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer’s representative.

3.09 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Provide the services of a VFD manufacturer factory technician to make all drive parameters and protective device settings:
   1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
   2. Provide documentation of VFD settings included but not limited to:
      a. Minimum speed.
      b. Maximum speed.
      c. Skip speeds.
      d. Current limit.
      e. Acceleration time.
      f. Deceleration time.

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 16412
LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage molded case circuit breakers.

B. Related sections:
   1. Section 01610 - Project Design Criteria.
   2. Section 01756 - Commissioning.
   3. Section 15050 - Common Work Results for Mechanical Equipment.
   4. Section 16305 - Electrical System Studies.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. AB 3. - Molded Case Circuit Breakers and Their Application.

B. Underwriter's Laboratories (UL):
   1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   2. 943 - Ground Fault Circuit Interrupters.

1.03 DEFINITIONS

A. In accordance with UL 489.

1.04 SYSTEM DESCRIPTION

A. Molded case thermal magnetic or motor circuit protector type circuit breakers as indicated on the Drawings and connected to form a completed system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 15050.

B. Product data:
   1. Catalog cut sheets.
   2. Manufacturer's time-current curves for all molded case circuit breakers furnished.

1.06 QUALITY ASSURANCE

A. Low voltage molded case circuit breakers shall be UL listed and labeled.
1.07 DELIVERY, STORAGE AND HANDLING
   A. As specified in Section 15050.

1.08 PROJECT OR SITE CONDITIONS
   A. As specified in Section 01610.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY
   A. Provide a Manufacturer's warranty meeting the requirement of General Conditions.

1.12 SYSTEM START-UP
   A. As specified in Section 01756.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. One of the following or equal:
      2. General Electric Company.
      4. ABB.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS
   A. General:
      1. Conforming to UL 489.
      2. Operating mechanism:
         a. Quick-make, quick-break, non-welding silver alloy contacts.
         b. Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.
         c. Mechanically trip free from the handle.
         d. Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
         e. Lockable in the "OFF" position.
3. Arc extinction:
   a. In arc chutes.
4. Voltage and current ratings:
   a. Minimum ratings as indicated on the Drawings.
   b. Minimum frame size 100A.
5. Interrupting ratings:
   a. Not less than the rating of the control panel.

B. Motor circuit protectors:
   1. Instantaneous only circuit breaker as part of a listed combination motor controller.
   2. Each pole continuously adjustable in a linear scale with 'LO' and 'HI' settings factory calibrated.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Terminals:
   1. Line and load terminals suitable for the conductor type, size, and number of conductors in accordance with UL 489.

B. Case:
   1. Molded polyester glass reinforced.
   2. Ratings clearly marked.

C. Trip units:
   1. Provide thermal.
   2. Thermal magnetic:
      a. Instantaneous short circuit protection.
      b. Inverse time delay overload.
      c. Ambient or enclosure compensated by means of a bimetallic element.

D. Molded case circuit breakers for use in panelboards:
   1. Bolt-on type.
      a. Plug-in type breakers are not acceptable.
   2. Ground fault trip devices as indicated on the Drawings.

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
   1. UL 489.
   2. Manufacturer's standard testing procedures.
PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION
   A. Install breakers to correspond to the accepted shop drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING
   A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL
   A. As specified in Section 15050.

3.09 ADJUSTING
   A. Adjust trip settings in accordance with Protective Device Coordination Study as accepted by the Engineer and in accordance with manufacturer's recommendations.
   B. Adjust motor circuit protectors in accordance with NEC and the manufacturer's recommendation based on the nameplate values of the installed motor.

3.10 CLEANING (NOT USED)

3.11 PROTECTION
   A. As specified in Section 15050.

3.12 SCHEDULES (NOT USED)

END OF SECTION
SECTION 17201
LEVEL MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY
A. Section includes:
   1. Ball float level switch.
B. Related sections:
   1. Section 01610 - Project Design Criteria.
   2. Section 15050 - Common Work Results for Mechanical Equipment.
C. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES (NOT USED)

1.03 DEFINITIONS (NOT USED)

1.04 SUBMITTALS
A. Furnish submittals as specified in Section 15050.

1.05 QUALITY ASSURANCE
A. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
B. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS
A. Project environmental conditions as specified in Section 01610.
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY
A. Provide a Manufacturer's warranty meeting the requirement of General Conditions.
1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Ball float level switch:
      a. Siemens Water Technologies Corp 9G-EF.
      b. ITT Flygt Model ENM-10.

2.02 MANUFACTURED UNITS

A. Ball float level switch:
   1. General:
      a. Free hanging, encapsulated body with a switch to determine position of float.
   2. Element:
      a. Mechanical switch encapsulated in waterproof floating ball of nominal diameter, supported by flexible PVC cable and jacket or heavy neoprene.
      b. The length of the PVC cable shall be, at a minimum, equal to sump depth plus 5 feet.
      c. Float: Provide Type 316 stainless steel or polypropylene, minimum 3 inches in diameter.
      d. An operating temperature rating: -30 degrees Fahrenheit to +150 degrees Fahrenheit.
      e. Mercury switches are not acceptable.
      f. Lead wires: Mounted in flexible waterproof PVC cable from switch to junction box terminals without splices.
   3. Switch:
      a. Single pole double throw contacts rated 10 amps resistive at 120 VAC.
      b. Suspend ball float and adjust for level setpoint as required.
   4. Components:
      a. Floats shall include Type 316 stainless steel clamp and brackets and 1/4 inch cable to allow testing of the float without entering the basin or wet well.
      b. Provide strain relief at both ends of the float cable.

2.03 ACCESSORIES

A. Provide sunshades for outdoor installation.

2.04 SOURCE QUALITY CONTROL (NOT USED)
PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 FIELD QUALITY CONTROL (NOT USED)

3.05 ADJUSTING (NOT USED)

3.06 CLEANING

A. As specified in Section 15050.

3.07 DEMONSTRATION AND TRAINING (NOT USED)

3.08 PROTECTION

A. As specified in Section 15050.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be as specified in the Specifications.

END OF SECTION
A/E: Carollo Engineers LEVEL SWITCHES

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Notes: Refer to Section 17201 for additional level switch requirements.
SECTION 17401
PRESSURE/VACUUM MEASUREMENT: DIAPHRAGM AND ANNULAR SEALS

PART 1   GENERAL

1.01 SUMMARY
   A. Section includes:
      1. Diaphragm seals.
      2. Annular seals.
   B. Related sections:
      1. Section 01610 - Project Design Criteria.
      2. Section 15050 - Common Work Results for Mechanical Equipment.
   C. Provide all seals identified in the Contract Documents.

1.02 REFERENCES (NOT USED)

1.03 DEFINITIONS (NOT USED)

1.04 SUBMITTALS
   A. Furnish submittals as specified in Section 15050.
   B. Additional requirements:
      1. Product data:
         a. Manufacturer's installation instructions.
         b. Seal type.
         c. Body materials.
         d. Diaphragm material.
         e. Fill fluid type.
         f. Seal size.
         g. Options.
         h. Process connection.

1.05 QUALITY ASSURANCE
   A. Examine the complete set of Contract Documents and verify the compatibility with
      the installed conditions including:
      1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
      2. Physical conditions:
         a. Installation and mounting requirements.
         b. Location within the process.
         c. Accessories: Verify that all required accessories are provided and are
            compatible with the process conditions and physical installation.
   C. Notify the Engineer if any installation condition does not meet the manufacturer's
      recommendations or specifications.
1.06 DELIVERY, STORAGE, AND HANDLING
   A. As specified in Section 15050.

1.07 PROJECT OR SITE CONDITIONS
   A. As specified in Section 01610.

1.08 WARRANTY
   A. As specified in Section 17050.

1.09 MAINTENANCE
   A. Provide spare annular seal for every size indicated in the project.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Diaphragm seals:
      1. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch gauge:
         One of the following or equal:
         a. Ashcroft:
            1) Flushing connection: Type 741.
            2) Without flushing connection: Type 740.
         b. Mansfield and Green:
            1) Flushing connection: Type SGT.
            2) Without flushing connection: Type SBT.
         c. Wika, Type L990.40.
         d. Rosemount.

2.02 MANUFACTURED UNITS
   A. Diaphragm seals:
      1. General:
         a. Diaphragm seal and pressure instrument shall be assembled by pressure instrument manufacturer and shipped as an assembly.
      2. Requirements:
         a. Seal type:
            1) Metallic diaphragm: Welded to upper housing.
            2) Elastomer diaphragm: Bonded to upper housing.
         b. Process connection: 1 inch NPT.
         c. Instrument connection: 1/2 inch NPT.
         d. Material Construction: Type 316 Stainless Steel.
         e. Provide 1/4-inch flushing connection in diaphragm lower housing or provide flushing ring.
         f. Flush port plug: Same material of construction as diaphragm lower housing.
         g. Provide fill/bleed connection.
         h. Mounting: As indicated in the Contract Documents.
i. Provide Type 316 stainless steel armored capillary for all remote installations.

j. Nuts and bolts: Type 316 stainless steel.

k. Materials of construction:
   1) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch:
      a) Diaphragm: Type 316 stainless steel.
      b) Lower housing: Type 316 stainless steel.
      c) Upper housing: Manufacturer's standard.
      d) Fill fluid: Silicon oil.

2.03 ACCESSORIES (NOT USED)

2.04 SOURCE QUALITY CONTROL

   A. As specified in Section 15050.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

   A. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

   B. Do not use Teflon thread seal tape on pressure instruments with silicon oil fill fluid.

3.04 FIELD QUALITY CONTROL

   A. As specified in Section 15050.

3.05 ADJUSTING (NOT USED)

3.06 CLEANING

   A. As specified in Section 15050.

3.07 DEMONSTRATION AND TRAINING

   A. As specified in Section 15050.

3.08 PROTECTION

   A. As specified in Section 15050.
3.09 SCHEDULES (NOT USED)

END OF SECTION
SECTION 17402
PRESSURE/VACUUM MEASUREMENT: INSTRUMENT VALVES

PART 1 GENERAL

1.01 SUMMARY
A. Section includes:
   1. Valve manifolds and instrument valves.
B. Related sections:
   1. Section 01610 - Project Design Criteria
   2. Section 15050 - Common Work Results for Mechanical Equipment
C. Provide all valves identified in the Contract Documents.

1.02 REFERENCES
A. As specified in Section 15050.

1.03 DEFINITIONS
A. As specified in Section 15050.

1.04 SUBMITTALS
A. Furnish submittals as specified in Section 15050.
B. Additional requirements:
   1. Product data:
      a. Valve type.
      b. Body material.
      c. Size.
      d. Options.
   2. Shop drawings:
      a. Mounting details for all manifold valves.

1.05 QUALITY ASSURANCE
A. As specified in Section 15050.
B. Examine the complete set of Contract Documents and verify that the valves are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
C. Notify the Engineer if any installation condition does not meet the valve manufacturer's recommendations or specifications.

D. Provide valves manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 15050.

B. Protect valve manifolds and protective coatings from damage during handling and installation. Repair coating where damaged.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01610.
   1. Provide valves suitable for the installed site conditions including, but not limited to, material compatibility, process, and ambient temperatures.

1.08 WARRANTY

A. Provide a Manufacturer's warranty meeting the requirement of General Conditions.

1.09 MAINTENANCE

A. As specified in Section 15050.

B. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Valve manifold manufacturers: One of the following or equal:
   1. Anderson Greenwood.
   2. Hex Valve.
   3. Noshok.
   4. Rosemount.

B. Block and bleed valve manufacturers: One of the following or equal:
   1. Anderson Greenwood.
   2. Hex Valve.

C. Gauge valve manufacturers: One of the following or equal:
   1. Anderson Greenwood.
   2. Hex Valve.

D. Level sensor isolation valve manufacturers: One of the following or equal:
   1. Indu-Tech Level Sensor Isolation Valve.
   2. DeZURIK Level Sensor Isolation Valve.
3. Tyco Rovalve Isolation Knife Gate Valve.

2.02 MANUFACTURED UNITS

A. Valve manifolds:
   1. General:
      a. Provide 2-valve, 3-valve, blowdown type 5-valve, or metering type 5-valve manifolds as indicated on the Drawings.
      b. Valve manifolds shall have one piece bonnet with a metal to metal seal to the valve body below the bonnet threads.
   2. Requirements:
      a. Bonnet lock pin to prevent accidental loosening.
      b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
      d. Manifold valves shall have straight through portion for bi-directional flow and easy roddable cleaning.
      e. Manifold valves shall allow for direct or remote instrument mounting.
      f. Shall be able to withstand pressures up to 6,000 psi for soft seat valves and 10,000 psi for hard seat valves at maximum 200 degrees Fahrenheit.
      g. Materials of construction:
         1) Body material: Type 316 stainless steel.
         2) O-Ring: Teflon.
   h. 2-Valve manifolds:
      1) 1 isolation valve and 1 drain/vent and calibration valve.
   i. 3-Valve manifolds:
      1) 2 isolation valves and 1 equalizing valve for differential pressure applications.
      2) Plugged vent connections used for vent/drain or calibration.
   j. Blowdown 5-valve manifold:
      1) 2 isolation valves, 1 equalizing valve, 2 blowdown valves for differential pressure applications.
   k. Metering 5-valve manifold:
      1) 2 isolation valves, 2 equalizing valves, 1 vent/drain and calibration valve for differential pressure applications.

B. Block and bleed valves:
   1. General:
      a. Valve shall provide process isolation and venting/draining capabilities.
      b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
      d. Valve shall not be used with fluids with high solids content, such as raw wastewater or sludge.
   2. Requirements:
      a. Materials of construction:
         1) Body material: Type 316 stainless steel.
         2) O-Ring: Teflon.

C. Gauge valves:
   1. General:
      a. Valve shall provide process isolation from pressure instrument.
      b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
2. Requirements:
   a. Materials of construction:
      1) Body material: Type 316 stainless steel.
      2) O-Ring: Teflon.

D. Level sensor isolation valves:
   1. General:
      a. Valve shall provide process isolation from level diaphragm.
      b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
   2. Requirements:
      a. Materials of construction:
         1) Body material: Type 316 stainless steel.
         2) Flange diameter size: 3 inches.

2.03 ACCESSORIES

A. Provide tube fitting, female NPT, or pipe butt weld connections if necessary.

B. Provide stainless steel concentric or eccentric pipe nipples when necessary.

2.04 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location and verify it will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of all valves.

3.04 FIELD QUALITY CONTROL (NOT USED)

3.05 ADJUSTING (NOT USED)

3.06 CLEANING

A. As specified in Section 15050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 15050.

B. Demonstrate performance of all valves to the Engineer before commissioning.
3.08 PROTECTION

A. As specified in Section 15050.

3.09 SCHEDULES (NOT USED)

END OF SECTION
SECTION 17405
PRESSURE/VACUUM MEASUREMENT: DIRECT

PART 1 GENERAL

1.01 SUMMARY
A. Section includes:
   1. Pressure transmitters and indicators.
B. Related sections:
   1. Section 01610 - Project Design Criteria.
   2. Section 15050 - Common Work Results for Mechanical Equipment.
C. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES (NOT USED)

1.03 DEFINITIONS
A. Specific definitions:
   1. Lower range value (LRV): Lowest pressure that the pressure transmitter is capable of measuring.
   2. Upper range value (URV): Highest pressure that the pressure transmitter is capable of measuring.
   3. Calibrated range: The range that the pressure transmitter is configured to measure. The low end of the calibrated range must be greater than the LRV of the transmitter. The high end of the calibrated range must be less than or equal to the URV. The calibrated range corresponds to the flow signal sent from the transmitter.

1.04 SUBMITTALS
A. Furnish submittals as specified in Section 15050.
B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE
A. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

B. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 15050.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01610.
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. Provide a Manufacturer's warranty meeting the requirement of General Conditions.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Rosemount: 3051 Series.
   2. Yokogawa: EJA Series.
   3. ABB: 266 Series.
   4. Endress & Hauser: Cerabar S Series.

2.02 MANUFACTURED UNITS

A. Pressure transmitters – direct:
   1. General:
      a. Pressure transmitter assembly shall include a diaphragm type pressure transducer and microprocessor based transmitter for measurement of gauge, vacuum, or absolute pressure.
   2. Performance requirements:
      a. Maximum ratio of total instrument range to calibrated span: 10 to 1.
      b. Accuracy:
         1) Reference accuracy: Plus or minus 0.075 percent of calibrated span, including effects of hysteresis, nonlinearity, and repeatability.
2) Total performance accuracy: Plus or minus 0.30 percent of calibrated span, including reference accuracy effects, static pressure and ambient temperature effects.

3) Stability: Plus or minus 0.15 percent of upper range limit over 5 years.

3. Element:
   a. Diaphragm type transducer integral to pressure transmitter.
   b. Diaphragm material: Stainless steel or ceramic.
   c. Process material compatibility:
      1) Verify all material compatibilities with the instrument manufacturer.

4. Transmitter:
   a. Power supply:
      1) 24 VDC - 2 wire loop powered.
      2) Power consumption: 3 VA maximum.
   b. Outputs:
      1) Isolated 4-20 mA DC with HART communication protocol.
   c. Provided with electronic microprocessor.
   d. Adjustments: Adjustable electronic zero and span, with elevated or suppressed zero as required by application. Adjustment shall be possible without mechanical fulcrum points or handheld configurator.
   e. Local display:
      1) 5-digit LCD.
      2) Scaled in engineering units.
   f. Enclosure:
      1) NEMA Type 4X.
   g. Over range protection: To maximum process line pressure.
   h. Conduit: 1/2 inch male NPT.

5. Components:
   a. Transmitter mounting:
      1) As specified in the Instrument Data Sheets.
      2) Provide all necessary hardware for transmitter mounting.

2.03 ACCESSORIES

A. Provide valve manifolds as specified in Section 17402:
   1. Mount valve manifold integrally to the transmitter.
   2. Valve manifold and transmitter shall be assembled by Manufacturer and shipped as an assembly.
   3. Provide remote or integral diaphragm seals as specified in the Instrument Data Sheets and in Section 17401.

2.04 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.
PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL (NOT USED)

3.05 ADJUSTING (NOT USED)

3.06 CLEANING

A. As specified in Section 15050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 15050.

3.08 PROTECTION

A. As specified in Section 15050.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION
# PRESSURE TRANSMITTERS

**Spec. No.** 17405  
**Rev.**

<table>
<thead>
<tr>
<th>No</th>
<th>By</th>
<th>Date</th>
<th>Revision</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
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</tbody>
</table>

**Instrument Tag No.**

**Service**  
Sludge

**P&ID**

**Pressure**

**Process Temperature**

**Ambient Temperature**

**Manufacture**

**Model No.**

**Pressure Transmitter Type**  
Direct

**Calibrated Span**

**Accuracy**

**Adjustable Range**

**Output Signal**  
4-20 Ma HART

**Body Rating**

**Process Flange Type**  
Threaded

**Drain/Vent**  
None

**Process Flange**  
MNPT

**Adapters**

**Housing**

**Bolts**

**Mounting Brackets**

**Conduit Entry Size**

**Isolating Diaphragm**  
316 stainless steel

**Fill Fluid**  
Silicon Oil

**Certification / Approval Type**

**Meter**

**Zero Span & Adjustment**

**Surge Protection**

**Custom Configuration**

**Manufacturer**

**Model Number**

**Manifold Style**

**Manifold Type**

**Notes:**

Refer to Section 17402 for additional instrument valve requirements.
SECTION 17710

CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design, fabrication and assembly of all instrumentation enclosures, control
      panels and components provided under this contract, including but not limited
      to:
      a. Custom built instrumentation and control panels, including all enclosures
         for hand stations controllers, low voltage power distribution and
         marshalling panels.
      b. Control panels furnished as part of equipment systems specified in other
         Divisions, such as vendor control panels (VCPs) and chemical feed
         panels.
      c. Control components.
      d. Control panel installation.

B. Related sections:
   1. Section 01610 - Project Design Criteria.
   2. Section 01612 - Seismic Design Criteria.
   3. Section 15050 - Common Work Results for Mechanical Equipment.
   4. Section 16262 - Variable Frequency Drives 0.50 - 50 Horsepower.
   5. Section 16412 - Low Voltage Molded Case Circuit Breakers.

C. Provide all control panels identified in Contract Documents.

1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):
      AC Power Circuits.

B. Underwriters Laboratories Inc. (UL):
   1. 508 - Standard for Industrial Control Equipment.
   2. 508A - Standard for Industrial Control Panel.
   3. 1283 - Standard for Electromagnetic Interference Filters.

1.03 DEFINITIONS

A. Specific definitions:
   1. The term "panel" in this Section is interchangeable with the term "enclosure."
1.04 SYSTEM DESCRIPTION

A. Panel dimensions:
   1. It is the responsibility of the Contractor or manufacturer to design and size all panels:
      a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.
      b. Maximum panel depth: 30 inches, unless otherwise indicated.

B. Structural design:
   1. Completed and installed panel work shall safely withstand seismic requirements at the project site as specified in Section 01612. Enclosures and internal equipment shall be braced to prevent damage from specified forces.

1.05 SUBMITTALS

A. Provide submittals as specified in Section 15050.

B. Provide a control panel hardware submittal for each control panel and enclosure being provided on this project, including but not limited to:
   1. Product data:
      a. Enclosure construction details and NEMA type.
      b. Manufacturer's literature and specification data sheets for each type of equipment to be installed within or on the panel or enclosure.
   2. Shop drawings:
      a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
         1) Provide draft for review and approval by Engineer. The Engineer has the authority to substantially alter initial panel layouts.
      b. Complete nameplate engraving schedule.
      c. Structural details of fabricated panels.
   3. Calculations:
      a. Provide installation details based on calculated shear and tension forces:
         1) Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.
      b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:
         1) Weight including panel internal components.
         2) Seismic forces and overturning moments.
         3) Shear and tension forces in connections.
      c. Cooling calculations, including but not limited to:
         1) Highest expected ambient temperature for the enclosure's location.
         2) Internal heat load.
         3) Exposure to direct sunlight.
         4) Dimensions of the enclosure in inches.
         5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.
C. Seismic design:
   1. Seismic panel construction:
      a. Seismic anchorage: Provide seismic design calculations and installation
details for anchorage of all panels, enclosures, consoles, etc. to meet
seismic requirements in Section 01612:
         1) Stamped by a Professional Engineer registered in the state where
the project is being constructed.
      b. For floor-mounted freestanding panels weighing 200 pounds or more
(assembled, including contents), submit calculations, data sheets, and
other information to substantiate that panel, base, and framing meet
minimum design strength requirements and seismic requirements as
specified in Section 01612. Calculations shall be signed and sealed by a
Professional Engineer licensed in the state where the cabinets and panels
will be installed.

1.06 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external
devices, wiring, equipment, and materials in a facility that is recognized by UL to
assemble and certify UL-labeled control panels:
   1. Provide all components and equipment with UL 508 listing.
   2. All control panels shall be UL 508A labeled, unless the equipment in the panel
and the design in the contract documents cannot be reasonably modified to
meet the requirements for UL 508A labeling.
   3. Provide fuses for all equipment that is not UL or UR listed.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Project environmental conditions as specified in Section 01610.
   1. Provide instruments suitable for the installed site conditions including, but not
limited to, material compatibility, site altitude, site seismic conditions, humidity,
and process and ambient temperatures.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01610.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. Provide a Manufacturer's warranty meeting the requirement of General Conditions.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. As listed below in the individual component paragraphs.

B. Provide instruments and other components performing similar functions of the same type, model, or class, and from 1 manufacturer.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:

1. Enclosures shall have the following properties:
   a. NEMA Type 1: Steel.
   b. NEMA Type 4: Steel with gasketed door, raintight.
   c. NEMA Type 4X: Type 316 stainless steel.
   d. NEMA Type 12: Steel with gasketed door, dusttight.
   e. NEMA Type 7: Cast aluminum.

B. Bolting material:

1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.
2. Carriage bolts for attaching end plates.
3. All other bolted joints shall have S.A.E. standard lock washers.

2.04 MANUFACTURED UNITS

A. Panels/enclosures:

1. Manufacturer: One of the following or equal:
   a. Rittal.
   c. Saginaw Control & Engineering.

2. Panel assembly:

   a. General guidelines for panel fabrication include:
      1) Continuous welds ground smooth.
      2) Exposed surfaces free of burrs and sharp edges.
      3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2-inch holes at 12-inch spacing to accommodate anchoring of freestanding enclosures to floor.

   b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

<table>
<thead>
<tr>
<th>Enclosure Height (inches)</th>
<th>Minimum Enclosure Steel Thickness (gauge)</th>
<th>Minimum Back Mounting Panel Thickness (gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted up to 48</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Up to 57</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>
### Enclosure Height

<table>
<thead>
<tr>
<th>Enclosure Height (inches)</th>
<th>Minimum Enclosure Steel Thickness (gauge)</th>
<th>Minimum Back Mounting Panel Thickness (gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>57 - 69</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>69 - 82</td>
<td>12, except 10 on back</td>
<td>10</td>
</tr>
<tr>
<td>82 or more</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

1) Use heavier sheet metal to meet seismic requirements at the project site or when required due to equipment requirements.

c. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.

d. Provide stiffeners for back mounting panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.

e. Door construction:
   1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
   2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
   3) Heavy-gauge piano-type continuous stainless steel hinges.
   4) For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
   5) Gasket installed to seal against roll lip on the enclosure opening.

f. Latches:
   1) For panels, provide each door with a 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.
      a) Provide padlock for each enclosure with padlock provisions.
   2) Include an oiltight key-locking, 3-point latching mechanism on each door:
      a) Provide 2 keys per panel.
      b) All locks keyed alike.
   3) For large NEMA Type 4 and NEMA Type 4X cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.

g. Panel cut-outs:
   1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
   2) Allow a minimum of 3-inch envelope around all displays, controllers, and monitors.
   3) Reinforce around cut-outs with steel angles or flat bars for the following:
      a) Large panel cutouts; for example, openings for local operator interfaces.
      b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.
3. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
   a. Minimum 14-gauge, Type 304 stainless steel.
   b. Captive stainless steel cover screws threaded into sealed wells.
   c. Inside finish: White polyester powder coating.
   d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.

B. Arrangement of components:
   1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
   2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices.
   3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
   4. All control-panel-mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.

C. Overcurrent protection:
   1. Main overcurrent device:
      a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:
         1) Door-mounted disconnect handles are not acceptable.
         2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
         3) Provide means to defeat the interlock.
         4) Lockable in the off position.
      b. Control panels supplied with 120 VAC:
         1) Provide an internal breaker with the line side terminals covered by a barrier.
         2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
   2. Provide circuit breakers as specified in Section 16412.
   3. Selection and ratings of protective devices:
      a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
      b. Voltage rating: Not less than the voltage of the application.
      c. Select current rating and trip characteristics to be suitable for:
         1) Maximum normal operating current.
         2) Inrush characteristics.
         3) Coordination of the protective devices to each other and to the source breaker feeding the panel.
   4. Provide a separate protective device for each powered electrical device:
      a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
b. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
   1) Size external fuse to open before any I/O-card-mounted fuses.
   2) Individual discrete inputs shall use a 0.5-ampere fuse.

c. Control loops can use individual 5-ampere fuse for the loop.

d. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.

5. Fuses for 4 to 20 milliamperes signals:
   a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
      1) Label shall not cover or interfere with equipment manufacturer's instructions.
   b. An individual 1/2-ampere fuse for each 4 to 20 milliamperes analog loop powered from the control panel.
   c. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
   d. Manufacturer: One of the following or equal:
      1) Ferraz Shawmut.
      2) Littelfuse.
      3) Bussmann.

6. Fuse holders:
   a. Modular type:
      1) DIN rail mounting on 35-millimeter rail.
      2) Touch-safe design: All connection terminals to be protected against accidental touch.
      3) Incorporates blown-fuse indicator.
      4) Plug-in style fuse terminals and fuse plugs are not acceptable.
   b. Provide nameplate identifying each fuse.
   c. Manufacturer: One of the following or equal:
      1) Phoenix Contact.
      2) Allen-Bradley 1492-FB Series B.

7. Control circuit breakers:
   a. DIN rail mounting on 35-millimeter rail.
   c. Rated for 250 VAC.
   d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
   e. Current ratings: As indicated on the Drawings or as required for the application.
   f. Provide nameplate identifying each circuit breaker.
   g. Manufacturer: One of the following or equal:
      1) Phoenix Contact.
      2) ABB.
      3) Allen-Bradley.
      4) Square D.

D. Conductors and cables:
   1. Power and control wiring:
      b. Insulation: 600 volts type MTW.
      c. Minimum sizes:
         1) Primary power distribution: 12 AWG.
2) Secondary power distribution: 14 AWG.
3) Control: 16 AWG.

d. Color:
   1) AC power (line and load): Black.
   2) AC power (neutral): White.
   3) AC control: Red.
   4) AC control: Orange for foreign voltages.
   5) DC power and control (ungrounded): Blue.
   6) DC power and control (grounded): White with Blue stripe.
   7) Ground: Green.

2. Signal cables:
   b. Insulation: 600 volts, PVC outer jacket.
   c. Minimum size: 18 AWG paired triad.
   d. Overall aluminum shield (tape).
   e. Copper drain wire.
   f. Color:
      1) 2-Conductor:
         a) Positive (+): Black.
         b) Negative (-): White and red.
      2) 3-Conductor:
         a) Positive (+): Black.
         b) Negative (-): Red.
         c) Signal: White.
   g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

E. Conductor identification:
1. Identify each conductor and cable with unique wire numbers with heat shrinkable cable markers.
2. Readily identified without twisting the conductor.

F. General wiring requirements:
1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
2. Install all components in accordance with the manufacturer’s instructions included in the listing and labeling.
3. Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.
4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
5. Provide power surge protection for all control panels.
6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
7. Provide non-metallic ducts for routing and organization of conductors and cables:
   a. Provide wiring separation plan.
   b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.
c. Provide separate ducts for signal and low-voltage wiring from power and 120-VAC control wiring:
   1) 120 VAC: Grey colored ducts.
   2) 24 VDC: White colored ducts.

8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
   a. Screw-on cable tie mounts.
   b. Hammer-on cable-tie mounting clips.
   c. Fingers of the nonmetallic duct.

9. Wire Ties:
   a. No wire ties inside wire duct.
   b. Use Panduit Cable tie installation tool, with tension control/cutoff.
   c. Verify cut ends are cut flush filed smooth after installed.

10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.

11. Support panel conductors where necessary to keep them in place.

12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.

13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
   a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.

14. The control panel shall be the source of power for all 120-VAC devices interconnected with the control panel including, but not limited to:
   a. Solenoid valves.
   b. Instruments both mounted in the control panel and remotely connected to the control panel.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

   A. Thermal management:
      1. Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range as specified in Section 01610.
      2. Air conditioner:
         a. Provide solid-state cabinet coolers or air conditioning units on all outdoor panels containing electronic components such as local operator interface (LOI) units, panel instruments, programmable logic controllers, or remote I/O.
         b. Provide filters on intake and exhaust openings.
         c. Increase panel sizes as needed to accommodate cooling units.
         d. Enclosure rating: NEMA Type 4X.
         e. Closed-loop design.
         f. Power supply: 120 VAC.
         g. Utilize a CFC-free refrigerant.
         h. Manufacturer: The following or equal:
            1) Kooltronic Integrity Series 21.
3. Heating:
   a. Provide all panels located in areas that are not climate controlled with thermostatically controlled strip heaters, except where all of the following conditions apply:
      1) The panel is not supplied with 120 V AC power.
      2) There are no electronics or moisture-sensitive devices in the enclosure.
      3) The panel is smaller than 38 inches high.

4. Heat exchanger:
   a. Closed-loop design ensuring separation of ambient air and clean air inside the cabinet.
   b. Filterless design to facilitate easy cleaning of the core.
   c. Mounting: As indicated on the Drawings.
   d. Manufacturer: The following or equal:
      1) Noren CC Series.

5. Enclosure temperature switch:
   a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
   b. Sensor and electronic enclosure.
   c. Accuracy: Within 2 degrees Fahrenheit.
   d. Manufacturer: The following or equal:
      1) Hoffman ATEMNC.
      2) Pfannenberg FLZ.

B. Pilot devices:
   1. General:
      a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
      b. Size:
         1) 30.5 millimeters.
      c. Heavy duty.
      d. Pushbuttons:
         1) Contacts rated:
            a) NEMA Type A600.
            2) Furnish 1 spare normally open contact and normally closed contact with each switch.
      e. Selector switches:
         1) Contacts rated:
            a) NEMA Type A600.
            b) Knob type.
         2) Furnish 1 spare normally open contact and normally closed contact with each switch.
         3) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
      f. Pilot lights:
         1) Type:
            a) LED for interior installations.
         2) Push to test.
         3) Lamp color:
            a) On/Running/Start: Red.
            b) Off/Stop: Green.
c) Power: White.
d) Alarm: Amber.
e) Status or normal condition: White.
f) Opened: Red.
g) Closed: Green.
h) Failure: Red.

2. Indoor and outdoor areas:
   a. NEMA Type 4/13.
   b. Manufacturer: One of the following or equal:
      1) Allen-Bradley Type 800T.
      2) Square D Class 9001, Type K.
      3) General Electric Type CR104P.
      4) IDEC TWTD Series.

3. Corrosive areas:
   a. NEMA Type 4X.
   b. Corrosion resistant.
   c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc.
   d. Manufacturer: One of the following or equal:
      1) Cutler Hammer Type E34.
      2) Square D Class 9001, Type SK.
      3) Allen-Bradley Type 800H.
      4) IDEC TWTD Series.

C. Potentiometer and slidewire transmitters:
   1. Provide a DC output in proportion to a potentiometer input.
   2. Potentiometer input:
      a. 100 ohms to 100 K ohms.
      b. Impedance Greater or equal to 1 M ohms.
      c. Zero turn-up: 80 percent of full-scale input.
      d. Span turn-down: 80 percent of full-scale input.
   3. Field-configurable output:
      a. Voltage and current: All conventional current loops and voltage control signals.
   4. Accuracy including linearity and hysteresis within 0.1 percent maximum at 25 degrees Celsius.
   5. Operating temperature: 0 to 55 degrees Celsius.
   6. Supply power: 9 to 30 VDC.
   7. Manufacturer: The following or equal:
      a. Phoenix Contact.

D. Signal isolators and converters:
   1. Furnish signal isolators that provide complete isolation of input, output, and power input:
      a. Minimum isolation level: 1.5 kilovolts AC/50 Hertz for at least 1 minute.
      b. Adjustable span and zero.
      c. Accuracy: Within 1.0 percent of span.
      d. Ambient temperature range: -20 to +65 degrees Celsius.
   2. Manufacturer: One of the following or equal:
      a. Phoenix Contact MCR Series.
      b. Acromag 1500, 600T, 800T, Flat Pack, or ACR Series.
      c. Action Instruments Q500 Series or Ultra SlimPakII.
d. AGM Electronics Model TA-4000.

E. Relays:
   1. General:
      a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
      b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
   2. General purpose:
      a. Magnetic control relays.
      b. NEMA Type A300 rated:
         1) 300 volts.
         2) 8 Amps continuous (minimum).
         3) 7,200 volt-amperes make.
         4) 720 volt-amperes break.
      c. Plug-in type.
      d. LED indication for energization status.
      e. Coil voltages: As required for the application.
      f. Minimum poles: DPDT.
      g. Touch-safe design: All connection terminals to be protected against accidental touch.
      h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
      i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
      j. Relays with screw-type socket terminals.
      k. Provide additional (slave/interposing) relays when the following occurs:
         1) The number or type of contacts shown exceeds the contact capacity of the specified relays.
         2) Higher contact rating is required in order to interface with starter circuits or other equipment.
      l. DIN rail mounting on 35-millimeter rail.
      m. Ice-cube-type relays with retainer clips to secure relay in socket.
      n. Integrated label holder for device labeling.
      o. Manufacturer: One of the following or equal:
         1) Phoenix Contact PLC Series.
         2) Potter and Brumfield Type KRP or KUP.
         4) Allen-Bradley Type 700 HC.
         5) Square D Type K.
   3. Latching:
      a. Magnetic-latching control relays.
      b. NEMA Type B300 rated:
         1) 300 volts.
         2) 10 Amps continuous.
         3) 3,600 volt-amperes make.
         4) 320 volt-amperes break.
      c. Plug-in type.
      d. DIN rail mounting on 35-millimeter rail.
      e. Coil voltage: As required for the application.
      f. Minimum poles: 2 PDT; as required for the application. Plus 1 spare pole.
      g. Touch-safe design: All connection terminals to be protected against accidental touch.
h. Clear cover for visual inspection.
i. Provide retainer clip to secure relay in socket.
j. Manufacturer: One of the following or equal:
   1) Square D 8501, Type K.
   2) IDEC TWTD Series.

4. Time delay:
a. Provide time-delay relays to control contact transition time.
b. Contact rating:
   1) 240 volts.
   2) 10 Amps continuous.
   3) 3,600 volt-amperes make.
   4) 360 volt-amperes break.
c. Coil voltage: As required for the application.
d. Provide pneumatic or electronic type with on-delay, off-delay, and on/off-delay:
   1) For off-delay, use true power-off time-delay relays. Where the required timing range exceeds capability of the off-delay relay use, signal off-delay where power loss will not cause undesirable operation or pneumatic time-delay relays.
e. Minimum poles: 2 PDT.
f. Units include adjustable dial with graduated scale covering the time range in each case.
g. Minimum timing range: 0.1 seconds to 10 minutes, or as required for the application.
h. Manufacturer: One of the following or equal:
   1) IDEC RTE Series.
   2) Agastat Series 7000 (pneumatic).
   3) Allen-Bradley Type 700-HR.

F. Terminal blocks:
1. DIN rail mounting on 35-millimeter rail.
2. Suitable for specified AWG wire.
3. Rated for 15 amperes at 600 volts.
4. Screw terminal type.
5. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
7. Construction: Polyamide insulation material capable of withstanding temperature extremes from -40 to 105 degrees Celsius.
8. Terminals: Plainly identified to correspond with markings on the diagrams:
9. Disconnect-type field signal conductor terminals with socket/screw for testing.
10. Identify terminals suitable for use with more than 1 conductor.
11. Position:
   a. So that the internal and external wiring does not cross.
   b. To provide unobstructed access to the terminals and their conductors.
13. Manufacturer: One of the following or equal:
   a. Phoenix Contact UK5 Series.
   b. Allen-Bradley 1492 Series.
G. Wire duct:
   1. Provide flame retardant plastic wiring duct, slotted with dust cover.
   2. Type:
      a. Wide slot.
      b. Narrow slot.
      c. Round hole.
   3. Manufacturer: The following or equal:
      a. Panduit.

H. Din Rail:
   1. Perforated Steel.
   2. 35mm width.
   3. 15mm deep.
   4. Provide 2 inch offset using one of the following:
      a. Offset brackets.
      b. Preformed standoff Din Rail Channel.

I. Surge protection devices:
   1. Control panel power:
      a. 120-volt control power source: Non-UPS powered:
         1) Provide surge protection device (SPD) for panel power entrances:
            a) Nominal 120-VAC with a nominal clamping voltage of 200 volts.
            b) Non-faulting and non-interrupting design.
            c) A response time of not more than 5 nanoseconds.
         2) Control panel power system level protection, non-UPS powered:
            a) Designed to withstand a maximum 10-kA test current of a 8/20 µs waveform according to IEEE C62.41.1 Category C Area.
            b) For panels receiving power at 120 VAC, provide surge protection at secondary of main circuit breaker.
            c) Provide both normal mode noise protection (line to neutral) and common mode (neutral to ground) surge protection.
            d) DIN rail mounting.
            e) Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
               1) Gastight connections.
               2) The terminal block: Fabricated of non-ferrous, non-corrosive materials.
            f) Visual status indication of MOV status on the input and output circuits.
            g) Dry contact rated for at least 250 VAC, 1 Amp for remote status indication.
            h) Meeting the following requirements:
               1) Response time: Less than or equal to 100 ns.
               2) Attenuation: Greater than or equal to -40 dB at 100 kilovolt-Hertz as determined by a standard 50-ohm insertion test.
               3) Safety approvals:
                  (a) UL 1283 (EMI/RFI Filter).
                  (b) UL 1449 2nd Edition.
            i) Manufacturer: One of the following or equal:
               1) Phoenix Contact Type SFP TVSS/Filter.
               2) Liebert Accuvar Series.
b. 120-volt control power source: UPS powered.
   1) Provide surge protection on the control power source at each panel containing power supplies, or electronic components including PLCs, I/O, HMI, and digital meters.
   2) Location:
      a) For panels with a UPS, install surge protection ahead of UPS and maintenance bypass switch.
      (1) Surge protection is not required for 120-VAC circuits that are only used for panel lights and receptacles.
      b) For panels receiving power at 480 VAC, provide surge protection on the 120-VAC control power transformer secondary.
   3) MCOV: 150 VAC.
   4) Surge capability (8/20 µs wave): 10 kA.
   5) Peak let-through: 620V L-N, 850V L-G.
   6) Manufacturer: One of the following or equal:
      a) Phoenix Contact Plugtrab PT Series.
      b) MTL Surge Technologies MA15 Series.

2. Instrument, data, and signal line protectors (traditional I/O) – panel mounted:
   a. Surge protection minimum requirements: Withstand a 10-kA test current of a 8/20 µs waveform in accordance with IEEE C62.41.1 Category C Area.
   b. DIN rail mounting on 35-millimeter rail (except field-mounted SPDs).
   c. SPDs consisting of 2 parts:
      1) A base terminal block.
      2) A plug protection module:
         a) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
         b) Base and plug coded to accept only the correct voltage plug.
   d. SPD manufacturer: One of the following or equal:
      1) Phoenix Contact Plugtrab Series.
      2) Bournes Series 1800.

3. Instrument, data, and signal line protectors (traditional I/O) – field mounted:
   a. Surge protection minimum requirements: Withstand a minimum 10-kA test current of a 8/20 µs waveform in accordance with IEEE C62.41.1 Category C Area.
   b. Manufacturer: One of the following or equal:
      1) Plugtrab PT Series.
      2) MTL TP48 Series.

J. Power supplies:
   1. Design power supply systems so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the system operation.
   2. Convert 120 VAC to 24 volt DC or other DC voltages required or as required for the application.
   3. Provide backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
   4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure:
      a. Provide automatic switchover upon module failure.
b. Alarm contacts monitored by the PLC.
5. Sized to provide 40-percent excess rated capacity.
6. UL 508C listed to allow full rated output without de-rating.
7. Provide fuse or short-circuit protection.
8. Provide a minimum of 1 set of dry contacts configured to change state on failure for monitoring and signaling purposes.
9. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change:
   a. With remote voltage sensing.
10. Operating temperature range: 0 to 50 degrees Celsius.
11. Touch-safe design: All connection terminals to be protected against accidental touch.
12. DIN rail mounting on 35-millimeter rail.
14. Manufacturer: One of the following or equal:
   a. Fully redundant:
      1) Phoenix Contact Quint Power Supply with SFB technology.
         a) Phoenix Contact Quint - O-ring redundancy module.
      2) IDEC PS5R Series:
         a) Witt redundancy Diode.
   b. Sola.
   c. Acopian.
   d. PULS.

K. Variable frequency drives:
   1. As specified in Section 16262.

L. Limit switches:
   1. NEMA Type 4X.
   2. AC contact rating 120 volts, 10 A.
   3. DC contact rating 125 volts, 0.4 A.
   4. Provide robust actuation mechanism not prone to degradation.
   5. Provide complete actuator mechanism with all required hardware.
   6. Allows for contact opening even during contact weld condition.
   7. UL approved.
   8. Operating temperature range: -18 to +110 degrees Celsius (0 to 230 degrees Fahrenheit).
   9. Manufacturer: One of the following or equal:
      a. Allen-Bradley 802 Series.
      b. Honeywell HDLS Series.
      c. Omron D4 Series.
      e. ABB.

M. Current switches:
   1. Operate from 120-VAC supply voltage.
   2. 1 normally open and normally closed contacts.
   3. Adjustable current setting.
   4. Manufacturer:
      a. Zelio® RM35.
2.07 ACCESSORIES

A. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.

B. Provide 15-inch floor stands or legs where needed.

C. Provide nameplate to each panel:
   1. Provide on all internal and external instruments and devices.
   2. Provide a nameplate with the following markings that is plainly visible after installation:
      a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
      b. Supply voltage, phase, frequency, and full-load current.
      c. Power source or circuit ID.
      d. Short-circuit current rating of the panel based on one of the following:
         1) Short-circuit current rating of a listed and labeled assembly.
         2) Short-circuit current rating established utilizing an approved method.

D. Provide a window kit where a transmitter with display is mounted inside a control panel. The window shall meet the following requirements:
   1. Safety plate glass.
   2. Secured by rubber locking seal.
   3. Allow full viewing of devices issuing visual process data or diagnostics.

E. Lighting:
   1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
      a. Covered or guarded.
      c. 120-volt, single-phase, 15-amp style plug.
      d. Provide 4,000 K, 900 Lumens – LED fixture.
         1) Provide additional fixtures for every 36 inches of width.

F. Receptacles:
   1. Provide 1 duplex receptacle located every 4 feet of enclosure width, spaced evenly along the back mounting panels.
   2. GFCI, 120-volt, single-phase, 15-amp style plug.
   3. Provide circuit breaker or fuse to limit receptacle draw to 5 amperes.

G. Grounding:
   1. Provide the following:
      a. Grounding strap between enclosure doors and the enclosure.
      b. Equipment grounding conductor terminals.
      c. Provide equipment ground bus with lugs for connection of all equipment grounding wires.
      d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding bus.
   2. Identify equipment grounding conductor terminals with the word "GROUND," the letters "GND," the letter "G," or the color green.
3. Signal (24 VDC) grounding: Terminate each drain wire of a signal (shielded) cable to a unique grounding terminal block, or common ground bus at the end of the cable as shown on the Loop Drawings.

4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.

5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.

6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.

7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.

8. Connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.

9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.

10. Bond together all remote and local control panels, processor racks, and conductive enclosures of power supplies and connect to the equipment-grounding circuit to provide a common ground reference.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finishes:

1. Metallic (non-stainless):
   a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.
   b. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer's recommended dry-film thickness and allowed to dry before applying the finish coat.
   c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
   d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.

2. Stainless steel:
   a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

B. Colors:

1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
3. Panel interiors shall be manufacturer's standard white.

2.11 SOURCE QUALITY CONTROL (NOT USED)
PART 3  EXECUTION

3.01  EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

3.02  PREPARATION (NOT USED)

3.03  INSTALLATION

A. Install enclosures so that their surfaces are plumb and level within 1/8 inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.

B. Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.

C. Provide floor stand kits for wall-mounted enclosures larger than 48 inches high.

D. Provide 3-1/2-inch high concrete housekeeping pads for freestanding enclosures.

E. Install gasket and sealing material under panels with floor slab cutouts for conduit:
   1. Undercoat floor-mounted panels.

F. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.

G. All holes for field conduits, etc. shall be cut in the field. There shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or mis-cut holes shall require that the entire enclosure be replaced.

H. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the Conduit Schedule, but shall be shown on the Loop Drawings prepared by the Contractor.

I. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.

J. Side Panels:
   1. Side panels shall be kept free off all control equipment and devices. Any deviation must be sent to the engineer in writing asking for a deviation.

3.04  ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)

3.05  REPAIRS/RESTORATION (NOT USED)

3.06  RE-INSTALLATION (NOT USED)
3.07 FIELD QUALITY CONTROL  
A. As specified in Section 15050.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING  
A. As specified in Section 15050.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION  
A. As specified in Section 15050.

3.12 SCHEDULES (NOT USED)

END OF SECTION
Spill or Overflow Observed at SWRP

*OIC Respects and Inspects the Spill.

Division Manager Notifies COO and Public Affairs Manager (PAM)

**Chief Engineer Notifies: Plant Ops Division Manager (331-6021)

Investigate the cause and stop the overflow.

*OIC Notifies: Chief Engineer & Operations Superintendent.

Overflow reaches MRGCD facility?

Yes

Mobilize Resources and mitigate.

No

Regulatory Notification Process Pg. 3

Follow Up Study and Mitigation Pg. 4

Immediately notify MRGCD, Pueblo of Isleta, and Valle de Oro.

Notification Contacts Pg. 2

* OIC = Operator In Charge
** If Division Manager does not answer, Chief Engineer contacts COO and PAM.
Overflow Emergency Response Plan-SWRP
Albuquerque Bernalillo County Water Utility Authority

Notification Contacts Pg. 1

Chief Engineer or Designee Contacts MRGCD (in sequence until contacted)
- Eric Zamora, Assistant Engineer of Operations – (505) 550-0854 Cell
- Larry Acosta, Isleta Dam Tender – (505) 459-8020 Office
- Joe Brem, Albuquerque Division Manager – (505) 249-5780 Cell
- Joe Baca, Equipment O&M Supervisor – (505) 249-5155 Cell
- Ray Gomez, Assistant Engineer – (505) 247-0234 Office
- Leonard Utter, Engineer Associate – (505) 362-0543 Cell

Chief Engineer or Designee Contacts Pueblo of Isleta (POI)

**Verbal Notification**

<table>
<thead>
<tr>
<th>Name</th>
<th>E-mail</th>
<th>Office</th>
<th>Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Dispatch:</td>
<td></td>
<td>(505) 869-3030</td>
<td></td>
</tr>
<tr>
<td>Envr. Div. Mgr.</td>
<td>Ramona Montoya</td>
<td><a href="mailto:POI36871@isletapueblo.com">POI36871@isletapueblo.com</a></td>
<td>(505) 869-7565</td>
</tr>
<tr>
<td>Water Qual. Spec.</td>
<td>Cody Walker</td>
<td><a href="mailto:POI36004@isletapueblo.com">POI36004@isletapueblo.com</a></td>
<td>(505) 869-9623</td>
</tr>
<tr>
<td>Envr. Tech.</td>
<td>Ruben Lucero</td>
<td><a href="mailto:POI36873@isletapueblo.com">POI36873@isletapueblo.com</a></td>
<td>(505) 869-9819</td>
</tr>
</tbody>
</table>

**E-mail Notification**

<table>
<thead>
<tr>
<th>Name</th>
<th>E-mail</th>
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</thead>
<tbody>
<tr>
<td>Governor</td>
<td>E. Paul Torres</td>
</tr>
<tr>
<td>1st Lt. Governor</td>
<td>Antonio Chewiwi</td>
</tr>
<tr>
<td>2nd Lt. Governor</td>
<td>Isidor Abeita</td>
</tr>
<tr>
<td>Gov.'s Exec. Assist.</td>
<td>Carmela Southerland</td>
</tr>
<tr>
<td>P.S. Exec. Director</td>
<td>Kenneth Pin</td>
</tr>
<tr>
<td>Envr. Div. Mgr.</td>
<td>Ramona Montoya</td>
</tr>
<tr>
<td>Nat. Res. Mgr.</td>
<td>Mark Dixon</td>
</tr>
<tr>
<td>UT. Div. Mgr.</td>
<td>Edwin Jaramillo</td>
</tr>
<tr>
<td>Water Qual. Spec.</td>
<td>Cody Walker</td>
</tr>
<tr>
<td>Envr. Tech.</td>
<td>Ruben Lucero</td>
</tr>
<tr>
<td>Solid Waste Supervisor</td>
<td>Joe Jojola</td>
</tr>
</tbody>
</table>

*Call Emergency Dispatch then all numbers until a live person is reached*

Post Logs of Calls to SharePoint

Chief Engineer or Designee Contacts
Valle de Oro National Wildlife Refuge

Refuge Manager: Jennifer Owen-White    cell: (505) 933-2708
MRG Coordinator: Monica Kimbrough    cell: (505) 463-7397
Overflow Emergency Response Plan-SWRP

Albuquerque Bernalillo County Water Utility Authority

Regulatory Notification Process. Pg. 1/2

Is spill contained in structure or tank, e.g. wet well, clarifier, etc.? Yes → Regulatory Reporting not required. No → Spill results from contractor’s work or construction activity?

Yes

Contractor verbally reports to Inspector and to Control Room. Control Room Calls Chief Engineer, Operations Superintendent, and OIC.

Inspector reviews and forwards to Chief Engineer. Follow Up Study and Mitigation Pg. 4

No

Within 12 hrs. or 24 hrs. of when spill was first observed or contractor verbally reports.

Within 5 days

Chief Engineer prepares written report and submits to Division Manager.

Division Manager reviews, signs, and submits to reporting agencies.

Within 12 hrs. or 24 hrs. of when spill was first observed or contractor verbally reports. Follow appropriate GWQB reporting process.

Oral report
• Pueblo of Isleta (12 hrs.)
• NM Environment Dept. (24 hrs.)
Email report
• EPA (24 hrs.)

Is GWQB Reporting necessary? (see box) Yes → GWQB Reporting

Ponded sewage on a pervious area may require additional reporting to the Ground Water Quality Bureau (GWQB). Circumstances presumed to require this reporting will be:
1. A sewage spill that:
   A. Is ponded for more than 24 hours and,
   B. At a depth of more than 12 inches over an area of more than 0.1 acre.

The normal 24-hour call to NMED Surface Water is presumed to meet the requirement for a 24-hour notification to the GWQB. The Chief Engineer shall be notified and shall be responsible for preparing the following additional reporting:
1. One week written report. Presumed the same as the five day report provided to NMED Surface Water.
2. 15-day Corrective Action Report.

No → Written Report

EPA
• NM Environment Department
• Pueblo of Isleta

Call NMED at:
(505) 827-0187
(505) 827-1041

Email:
R6_NPDES_Reporting@epa.gov
Sandra.gabaldon@state.nm.us.
POI36871@isletapueblo.com,
Cc: COO, Comp Div Manager, Plant Op Manager, Comp Div Adm Supv. (Spill/Overflow Template)
Is the cause of the incident straightforward? (determined by the Chief Engineer)

- **Yes**: Chief Engineer assigns staff to investigate the incident and prepare a memorandum.
  - Identify causes and mitigation as appropriate.
  - Memorandum approved by the Chief Engineer and issued to Division Manager to review.
  - Finalized Report submitted to COO by Division Manager

- **No**: Appropriate study team assigned by Centralized Engineering.
  - Identify causes and mitigation as appropriate.
  - Study team develops and issues a report to COO.
RDT PILOT VENDOR STAGING AREA

ALL CONNECTIONS TO EXISTING PIPING WILL BE MADE WITH CAMLOCK FITTINGS.

EXISTING 4-INCH UWAS PIPE CONNECTION. SEE PHOTO NO. 1 FROM BASEMENT LEVEL UWAS PIPE FITTING.

RDT PILOT SUB-NATANT DISCHARGE OVER NORTH WEST DAF WALL INTO DAF SUB-NATANT.

RDT PILOT TWAS DISCHARGE. EXISTING 2-INCH PIPE CONNECTION TO DAF TWAS HOPPER. AT NORTH EAST CORNER OF DAF. SEE PHOTO NO. 2

480 VOLT POWER SUPPLIED BY THE WATER AUTHORITY.

EXISTING 1 1/2-INCH REUSE PIPE CONNECTION ON UPPER LEVEL. SEE PHOTO NO. 3

EXISTING ROLL UP DOOR, SEE NORTH ELEVATION OF DAF BUILDING PHOT NO. 4

RDT PIPE UTILITY CONNECTIONS FOR PILOT DEMONSTRATION

FIGURE 2

ALBUQUERQUE BERNALLILO COUNTY WATER UTILITY AUTHORITY
SOUTHSIDE WATER RECLAMATION PLANT
PHOTO 3 - REUSE PIPE CONNECTION