Riverside County
Perris, California

SPECIFICATION NO. 1386S
SKINNER 1 LIFT STATION REPLACEMENT
VOLUME 2 OF 2
Work Order # 004256

A PUBLIC WORKS PROJECT

Contents:
Specifications | Notice Inviting Bids | Bidding Requirements | Bid Forms | Contract Forms | Conditions of Contract

Paul D. Jones, II, P.E. - General Manager

Safety is of paramount and overriding importance to Eastern Municipal Water District

Visit our website at www.emwd.org to view currently advertised projects
Navigate to Construction ➔ Construction Bid Opportunities
# TABLE OF CONTENTS

## VOLUME 1

### BIDDING REQUIREMENTS

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>00000</td>
</tr>
<tr>
<td>00010</td>
</tr>
<tr>
<td>00012</td>
</tr>
<tr>
<td>00014</td>
</tr>
<tr>
<td>00016</td>
</tr>
<tr>
<td>00018</td>
</tr>
<tr>
<td>00020</td>
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<tr>
<td>00024</td>
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<tr>
<td>00027</td>
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<tr>
<td>00028</td>
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<tr>
<td>00032</td>
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<td>00036</td>
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<td>00038</td>
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<td>00042</td>
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<td>00044</td>
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<td>00048</td>
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<tr>
<td>00050</td>
</tr>
<tr>
<td>00052</td>
</tr>
<tr>
<td>00056</td>
</tr>
<tr>
<td>00057</td>
</tr>
<tr>
<td>00058</td>
</tr>
</tbody>
</table>

### GENERAL CONDITIONS

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>00062</td>
</tr>
<tr>
<td>00064</td>
</tr>
<tr>
<td>00066</td>
</tr>
</tbody>
</table>

### SPECIAL CONDITIONS

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>00100</td>
</tr>
</tbody>
</table>
# CONTRACT DRAWINGS

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>00200</td>
<td>Section P Standard &amp; Construction Drawings (list)</td>
<td>P-1 thru P-2</td>
</tr>
</tbody>
</table>

# EMWD DETAILED PROVISIONS

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>01000</td>
<td>General Safety Requirements</td>
<td>1 thru 8</td>
</tr>
<tr>
<td>01026</td>
<td>Schedule of Values</td>
<td>1 thru 6</td>
</tr>
<tr>
<td>01185</td>
<td>Work Restrictions and Sequence of Work <em>(Custom)</em></td>
<td>1 thru 12</td>
</tr>
<tr>
<td>01310.1</td>
<td>Project Control Schedule - Small Job</td>
<td>1 thru 12</td>
</tr>
<tr>
<td>01381</td>
<td>Pre-Const. Audio Video Taping Above Ground Facilities</td>
<td>1 thru 4</td>
</tr>
<tr>
<td>01430.1</td>
<td>Maintenance Manual Requirement Section <em>(Custom)</em></td>
<td>1 thru 8</td>
</tr>
<tr>
<td>01501</td>
<td>Field Testing and Commissioning of Equipment <em>(Custom)</em></td>
<td>1 thru 8</td>
</tr>
<tr>
<td>02052</td>
<td>General Demolition Work <em>(Custom)</em></td>
<td>1 thru 12</td>
</tr>
<tr>
<td>02201</td>
<td>Construction Methods and Earthwork</td>
<td>1 thru 26</td>
</tr>
<tr>
<td>02210</td>
<td>Site Grading</td>
<td>1 thru 8</td>
</tr>
<tr>
<td>02221</td>
<td>Trenching, Backfilling, and Compacting</td>
<td>1 thru 10</td>
</tr>
<tr>
<td>02252</td>
<td>Control Density Fill</td>
<td>1 thru 4</td>
</tr>
<tr>
<td>02444</td>
<td>Chain Link Fencing</td>
<td>1 thru 6</td>
</tr>
<tr>
<td>02513</td>
<td>Asphalt Concrete Paving</td>
<td>1 thru 4</td>
</tr>
<tr>
<td>02762</td>
<td>Furnish &amp; Inst. Plastic Sewer Pipe Sys.</td>
<td>1 thru 14</td>
</tr>
<tr>
<td>02768</td>
<td>Furnish and Install PVC Force Main</td>
<td>1 thru 12</td>
</tr>
<tr>
<td>03150</td>
<td>Formwork for Cast-in-Place Concrete</td>
<td>1 thru 6</td>
</tr>
<tr>
<td>03200</td>
<td>Reinforcing</td>
<td>1 thru 6</td>
</tr>
<tr>
<td>03300</td>
<td>Cast-in-Place Concrete</td>
<td>1 thru 38</td>
</tr>
<tr>
<td>05120</td>
<td>Structural Steel and Miscellaneous Metal Work <em>(Custom)</em></td>
<td>1 thru 20</td>
</tr>
<tr>
<td>07920</td>
<td>Sealants and Caulking</td>
<td>1 thru 6</td>
</tr>
<tr>
<td>09900</td>
<td>Painting and Protective Coatings</td>
<td>1 thru 48</td>
</tr>
</tbody>
</table>
EMWD DETAILED PROVISIONS (Continued)

11005  General Mechanical and Equipment  1 thru 18
11073  Submersible Non-Clog Sewage Pumping Units *(Custom)*  1 thru 14
11250  Outdoor Standby Power Diesel Engine Generator Set *(Custom)*  1 thru 40
13025  Prefabricated Sewage Lift Station *(Custom)*  1 thru 24
15070  Process Piping and Appurtenances *(Custom)*  1 thru 24
15081  Gaskets  1 thru 2
15089  Nuts and Bolts  1 thru 2
15100  Process Valves *(Custom)*  1 thru 24
16010  General Electrical Requirements  1 thru 28
16040  Short Circuit/Coordination Study and Arc-Flash Hazard Study  1 thru 26
16051  Basic Electrical Materials and Methods *(Custom)*  1 thru 60
16255  Automatic Transfer Switch *(Custom)*  1 thru 14
16480  Motor Control Centers, Switchboards, and Panelboards.  1 thru 62
16950  Custom Control Panels  1 thru 30
17006  Instrumentation and Control Components *(Custom)*  1 thru 28

APPENDICES

Appendix A  Approved Materials List
Appendix B  Demolition Photos
Appendix C  Geotechnical Report for the Skinner 1 Lift Station Replacement Project
Appendix D  Record Drawings for the Skinner 1 Lift Station
Appendix E  Pump Station Control Panel Diagrams
Appendix F  Flygt Pre-Negotiated Equipment Proposal
Appendix G  Shutdown Coordination Schedule
Appendix H  Asbestos Survey Report
Appendix I  Paint Sample Analysis Report
PART 1 - GENERAL

1.01 DESCRIPTION
These General Mechanical and Equipment Provisions, which apply to all systems and equipment, are hereby made a part of each and all of the separate Sections of this Specification. Contractor shall direct the attention of all Subcontractors and suppliers of mechanical and related appurtenances for the Work to the provisions of the Contract Documents located in these specifications.

1.02 MANUFACTURER'S EXPERIENCE
Unless specifically named in the detailed Specifications, a manufacturer shall have furnished equipment of the type and size specified which has demonstrated successful operation and is in regular use.

1.03 FACTORY INSPECTION
The District or its representative may inspect fabricated equipment at the factory without cost to the Contractor. The Contractor shall notify the District in sufficient time so that factory inspection can be arranged. Factory inspection will be made after manufacturer has performed satisfactory checks, adjustments, tests and operations. Approval of equipment at the factory only allows the manufacturer to ship the equipment to the site, and does not constitute final acceptance by the District.

1.04 STANDARD OF QUALITY
Items of equipment are specified by the name of the manufacturer for the purpose of establishing a standard of quality and acceptable experience. Substitute equipment will be acceptable if it can be demonstrated to the District that the substitute is in strict accordance with the Specifications and equal in quality to those models specifically named. Manufacturers specified have been determined by the District to meet or exceed the minimum acceptable standard for the designated equipment style and model. Refer to the General Provisions for requirements pertaining to substitutions and equals. All mechanical equipment furnished under the Specification shall be new and of current design.

1.05 ADAPTATION OF EQUIPMENT
No responsibility for alteration of a planned structure to accommodate substitute equipment will be assumed by the District. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All revisions to structures, mechanical, electrical, or other work made necessary by such substitution shall be approved by the District and the cost of said revisions, including cost of redesign, shall be made at the Contractor's expense. Refer to General Provisions.
A. **Horsepower Ratings.** Horsepower ratings specified and/or shown for the proposed equipment are in accordance with the best information available to the District. In the event any equipment item proposed by the Contractor should require motors with larger horsepower rating than indicated on Electrical Drawings, it shall be the Contractor's responsibility to provide the proper control equipment, required modifications to motor control centers, starting equipment, feeder and branch circuit, and accessories as required to make the installation comply with the electrical code and to prevent excessive voltage drop without added cost to the District.

B. **Equipment.** Where equipment to be furnished is installed in an existing enclosure or adjacent to existing equipment, the Contractor shall field check the dimensions of existing equipment, location of conduits, etc., and shall familiarize himself with all existing conditions and difficulties to be encountered in performing such work.

1.06 **GUARANTEES AND WARRANTIES**

The Contractor shall guarantee all equipment in accordance with the Conditions of the Contract. In addition to the general guarantee requirements, equipment guarantee shall cover (1) faulty or inadequate design; (2) improper assembly or erection; (3) defective workmanship or materials; and (4) leakage, breakage, or other failure. For equipment bearing a manufacturer's warranty in excess of one (1) year, furnish a copy of the warranty to District with District named as beneficiary. The period of all guarantees shall be initiated from the date of the District written acceptance of the Work.

1.07 **SUBMITTALS**

Refer to Section F Labor and Construction, F-30 "Submittals" and to specific Divisions and Sections for additional submittal requirements.

A. **Shop Drawings.** Shop drawings shall be submitted to the District in complete sets indexed by Specification paragraph and Drawing number describing the various equipment items or systems. Unless otherwise specified or directed, submit shop drawings for all mechanical equipment specified herein.

B. **Earthquake Design Data.** Submit with the shop drawings complete calculations or test results, details of constructions, and method of attachment for all manufactured products showing compliance with Paragraph 3.11, "Earthquake Design and Restraint." The calculations and details shall be signed by a Professional Engineer who has demonstrated proficiency in Structural Engineering or Civil Engineering and is registered in the State of California.

C. **Instruction Manuals.** Prepare and submit instruction manuals covering all mechanical equipment and machinery specified herein.
D. Manufacturers' Certified Reports. Each equipment manufacturer, or his authorized representative, shall submit a notarized written report with respect to his equipment certifying that (1) the equipment has been properly installed and lubricated under his supervision, (2) the equipment is in accurate alignment, (3) he was present when the equipment was placed in operation, (4) he has checked, inspected, and adjusted the equipment as necessary, (5) the equipment is free from any undue stress imposed by connecting piping or anchor bolts, (6) has been satisfactorily operated under full load conditions, (7) he has inspected his equipment during the operational demonstrations and system validation tests to the extent specified, and (8) the equipment is fully covered under the terms of the guarantee.

E. Submittals For Operational Demonstration and System Validation Tests

1. Operation Demonstration. When the Contractor's application for a progress payment equals or exceeds 75% of the Contract value for the first time, submit a detailed and comprehensive procedure plan for performance of each operation demonstration required. Identical equipment items may be covered under one plan. Include an estimated date and duration for each procedure and personnel required.

2. System Validation Tests. When the Contractor's application for a progress payment equals or exceeds 75% of the Contract value for the first time, submit a detailed and comprehensive procedure plan for performance of each separate validation test and for each validation test that covers two or more systems. Each procedure plan shall describe and itemize the involved system, including associated electrical equipment and instrumentation and control systems, and shall include evidence of an organized step-by-step procedure properly coordinating the efforts of various trades and manufacturers' representatives involved and of the operation of the facilities. Procedures shall include an estimated duration and date for each procedure and the personnel required.

3. Procedure Plan Information. In addition to the information specified above, each procedure plan shall include the following information as applicable.

   a) Description of temporary procedure facilities, including Drawings and sketches as required to fully illustrate the facilities.

   b) List of test materials and estimated quantities.

   c) List of instruments, measuring and recording devices, and other test equipment, whether a part of the plant or furnished separately for temporary use.

   d) Names of supervising and inspecting manufacturers.
e) Complete listing of all functional parameters to be observed and recorded.

f) Recording intervals.

4. Records Materials. Submit samples of the forms, charts, and other materials to be used in recording demonstration and validation test results.

5. Results. Within 10 days after completion of each procedure plan submit copies of all recordings and results of all operational demonstrations and system validation tests.

F. Electric Motors. Conform with applicable requirements specified in Sections 16150 and 16151 herein.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING
Box, crate, or otherwise enclose and protect equipment during shipment, handling, storage, and following installation until final acceptance of the project. Keep equipment dry and covered from exposure to weather. Store pumps, motor, electrical equipment, and equipment having anti-friction or sleeve bearings in weathertight storage facilities. Lift large equipment items only at the points designated by manufacturer.

A. Factory Painted Surfaces. Protect against impact, abrasion, discoloration, and other damage. Repair damage as directed and approved (Refer to Section 09871).

B. Electrical Equipment. Maintain electrical equipment, controls, and keep insulation dry at all times. Keep heaters in equipment connected and operating until equipment is placed in operation.

1.09 JOB CONDITIONS
Drawings are diagrammatic and show the intended arrangement of principle apparatus, piping, and appurtenances. Conform to Drawings as closely as possible and exercise care to secure approved headroom and space conditions, neat arrangement of piping, valves, hangers, and like items, and to overcome structural interferences. Verify dimensions and conditions at the place of installation, and install materials and equipment in the available spaces. Submit written details and reasons for proposed deviations from Drawings and Specifications, and do not deviate therefrom unless authorized by Field Order or Change Order. If approved changes require alteration of structures or related work, make such alterations as approved in advance by District at no additional cost to District.

1.10 EQUIPMENT
All equipment furnished shall be complete, ready for installation and operation. All bolts, nuts, washers, mounting plates, bed plates, bases, anchor bolts and other miscellaneous items necessary to form a complete, installed, operational system shall be furnished whether specifically specified or not.
PART 2 - PRODUCTS

2.01 MATERIALS AND WORKMANSHIP
All equipment furnished shall be new and guaranteed free from defects in materials, design, and workmanship. It shall be the manufacturer’s responsibility to ascertain the conditions and service under which the equipment will operate and to warrant that operation under these conditions shall be successful. All parts of the equipment shall be amply proportioned for all stresses that may occur during fabrication, erection, and intermittent or continuous operation.

All equipment shall be designed, fabricated, and assembled in accordance with the best modern engineering and shop practice. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests. Materials shall be suitable for service conditions. Iron castings shall be tough, close-grained gray iron free from blowholes, flaws, or excessive shrinkage and shall conform to ASTM A48. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction. All structural members shall be considered as subject to shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall have a minimum nominal thickness of 1/4-inch. Provide equipment and materials suitable for the service conditions and meeting standard specifications such as ANSI, ASME, AWWA, ASTM, NEMB, UBC, and UL. The location of the fabricator and his shop schedule shall be furnished to the District prior to the beginning of fabrication so that the District can schedule shop inspection.

2.02 LUBRICATION

A. Lubricants. Provide lubricants of types recommended by equipment manufacturers, quantities sufficient for consumption prior to completion, testing, and final acceptance.

B. Lubrication Systems. Lubrication of equipment shall ensure constant presence of lubricant on all wearing surfaces. Lubricant fill and drain openings shall be readily accessible. Easy means for checking the lubricant level shall be provided. Prior to testing and/or operation, the equipment shall receive the prescribed amount and type of lubricant as required by the equipment manufacturer. Equipment lubrication systems shall be systems that require attention during start up of shut down, and shall not waste lubricants.
General Mechanical and Equipment Provisions
Section 11005 – 6

2.03 STRUCTURAL STEEL FABRICATIONS
Conform to "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" of the AISC unless otherwise indicated or specified. Design all fabrications for dynamic and vibratory loadings. Use structural steel shapes conforming to ASTM A36, A440, A500, A501, A570, A618, or equal, as applicable. Conform welding to AWS D1.1 Structural Welding Code. Galvanized specified items in accordance with ASTM A123, A153, or A386 as applicable; use galvanized bolts and fasteners with galvanized assemblies.

2.04 EQUIPMENT BASES AND BEDPLATES
Mount equipment assemblies on a single heavy cast iron or welded steel bedplate unless otherwise shown or specified. Provide bases and bedplates with machined support pads, tapered dowels for alignment or mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. Continuously weld seams and contact edges between steel plates and shapes, and grind welds smooth. Do not support machinery or piping on bedplates other than that which is factory installed. Provide jacking screws in equipment bases and bedplates to aid in leveling prior to grouting. Provide plates of minimum thickness of 1/4-inch. Pump bedplates shall include a drip lip and provisions for directing leakage to a single disposal point.

2.05 ANCHORS AND SLEEVES
Each equipment manufacturer shall furnish the required anchor bolts, nuts, washers, and sleeves of adequate design for securing bases and bedplates to concrete bases. Provide sleeves of at least 1-1/2 times anchor bolt diameter. Anchor bolts shall be Type 316 stainless steel. Provide anchor bolts of length to allow for 1-1/2 inch of grout under baseplates and adequate anchorage into structural concrete unless otherwise shown or specified. Conform to designs for attachments to resist seismic forces, as applicable.

2.06 SAFETY GUARDS
Cover belt or chain drives, fan blades, couplings, exposed shafts and other moving or rotating parts on all sides with safety guards conforming to all Federal, state, and local codes and regulations pertaining; conform to the most restrictive requirements. Safety guards shall be free of all sharp edges and corners. Use corrosion-resistant materials at least equivalent to hot-dip galvanized steel. Safety guards shall be fabricated from 16USS gauge, or heavier, galvanized or aluminum-clad steel or 1/2-inch mesh galvanized expanded metal. Design guards for easy installation and removal. Provide necessary supports, accessories, and fasteners, of hot-dip galvanized steel or stainless steel. Design guards in outdoor locations to prevent entrance of rain and dripping water.

2.07 DRIVE UNITS
Provide drive units designed with a AGMA rating and service factor suitable for 24 hour continuous duty service under operating load, constructed to preclude oil leakage around shafts. Drive unit housings shall be constructed of high grade cast iron, welded steel, or other suitable material. Thermal rating of each unit shall exceed the design load or proper cooling devices shall be provided. All drives shall be designed specifically for the service conditions under which they are to operate.
A. **Motor Ratings.** Provide drive motors having nameplate horsepower rating at least equal to 110 percent of the theoretical brake horsepower required to drive equipment under full load for conditions specified, including all losses in speed reducers and power transmission. Refer also to Section 16150.

B. **V-Belt Drives.** Equip each V-belt with a sliding base or other suitable tension adjustment. Where motors are mounted above the driven machine on a pedestal, the belt tensioning shall be accomplished by four studs which are double nutted to the motor plate to raise and lower the motor plate. Hinges with jacking screw to tension the belts shall not be used. Provide drives having a service factor of at least 1.6 at maximum torque using nameplate rating of driving motor.

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### 2.08 GEARS

Provide oil-lubricated totally-enclosed gear reducers and increasers.

A. **Service Ratings.** Each gear shall have a nameplate service horsepower rating equal to the nameplate rating of the driving motor. Each gear shall have mechanical and thermal capacity equal to, or greater than an equivalent horsepower determined by multiplying the service horsepower rating by the specified service factor recommended by AGMA for heavy duty service, except each set of worm gears shall have a minimum service factor of 1.50.

B. **Thermal Rating.** Obtain thermal rating for the equivalent horsepower without auxiliary cooling equipment such as heat exchangers. Design units to operate continuously for the conditions specified in a location where ambient temperatures vary from 30° to 130° F. If a cooling coil is required, provide minimum 1-inch diameter tubing and a 1-inch solenoid supply water valve with the gear.

C. **Bearings.** Provide anti-friction bearings throughout, designed to give 20,000 hours B100 life for the specified horsepower in continuous operation, of proportions, mounting and adjustment consistent with acceptable modern practices for applied radial and thrust loads at speeds involved. Provide thrust bearing rates at 1-1/2 times the maximum thrust loadings involved.

D. **Gear Nameplates.** Equip each gear with an AGMA nameplate which shows service horsepower, actual service factor for actual mechanical or thermal rating as applicable, and AGMA gear Class I rating.

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### 2.09 ELECTRICAL MOTORS FOR MECHANICAL EQUIPMENT

Conform with applicable requirements of Division 16.
2.10 CONTACTS
For interlock or failure indicating contacts specified to be supplied as part of equipment, provide SPDT switches rated for 120 VAC, 60 Hz at 5 amperes resistive or 3 amperes inductive loading, terminated at screw-type barrier strips in a NEMA 4 enclosure, unless otherwise shown or specified.

2.11 GAUGES
Gauges shall be installed in the suction (where applicable) and discharge piping of each pump and blower. The gauges shall be 4-inch diameter, liquid filled and shall include a petcock (Corp stop) between the pump/blower piping and the gauge. For solids bearing or corrosive fluids, a diaphragm gauge isolator shall be provided. Suction gauges shall be of the compound type and shall have a range as shown on the Drawings. Discharge gauge ranges shall be a standard commercially available range as shown on the drawings.

2.12 NAMEPLATES AND DATA PLATES
Provide Type 302, 304, or 316 stainless steel nameplates of ample size with embossed or preprinted lettering, fastened to the equipment in a prominent place with corrosion-resisting pins. On nameplates, display manufacturer, serial number, date of manufacture, model number and essential operating characteristics. Inscribe data plates with specific or directed information.

2.13 PAINTING
Conform to applicable requirements of Section 09871 "Coating System for Water Pumping Plants" and following requirements unless modified or superceded under other Sections.

A. Factory Painting. On mechanical equipment, drives, starters, control panels and other similar self-contained or enclosed components, apply a factory primer and high-quality oil-resistant baked industrial enamel finish. Paint or otherwise protect surfaces that are inaccessible after assembly by a method which provides protection for the life of the equipment.

B. Shop Priming. Apply one or more shop coats of metal primer on surfaces to be finish painted at the site to protect surfaces until finished. Use primers specified for the required paint system in Section 09871.

C. Rust Preventive. Coat machined, polished, or other ferrous surfaces, and non-ferrous surfaces, which are not to be painted, with rust preventive compound, Dearborn Chemical No-Ox-Id 2W, Houghton Rust Veto 344, Rust-Oleum 4-9, or approved equal.
PART 3 - EXECUTION

3.01 COORDINATION
The Drawings show in a diagrammatic form the arrangements desired for the principle apparatus, piping, and similar appurtenances, and shall be followed as closely as possible. Proper judgment must be exercised in carrying out the work to secure the best possible headroom and space conditions throughout, to secure neat arrangement of piping, valves, fixtures, hangers, and similar appurtenances, and to overcome local difficulties and interferences of structural conditions wherever encountered.

The Contractor shall take all measurements for his work at the installation sites, verify all subcontractor drawings and be responsible for the proper installation, within the available space for the apparatus specified and shown on the Drawings, and must secure the approval of the District for any variations before making any changes.

Refer to pertinent Sections for items of equipment to be assembled of several components under the unit responsibility of one manufacturer. To coordinate this requirement, the Contractor shall monitor and verify the unit responsibility processes and submit the following information to the District in writing on a monthly basis:

A. Shipment dates of the various components to the unit responsibility manufacturers.
B. Scheduled dates of factory tests by unit responsibility manufacturers.
C. Scheduled shipments dates to site of unit responsibility items.
D. Scheduled arrival date, installation date and start-up date.

3.02 INSPECTION
Inspect each item of equipment for damage, defects, completeness, and correct operation before installing. Inspect previously installed related work and verify that it is ready for installation of the equipment.

3.03 PREPARATION
Prior to installing equipment, ensure that installation areas are clean and that concrete or masonry operations are completed. Maintain the areas in a broom-clean condition during installation operations. Clean, condition, and service equipment in accordance with the reviewed Instruction Manuals and requirements in other Sections of these Specifications before installing.
3.04 MANUFACTURERS' SUPERVISION AND INSTALLATION CHECK
Each equipment manufacturer shall furnish the services of an authorized representative specially trained and experienced in the installation of his equipment to (1) supervise the equipment installation in accordance with the reviewed Instruction Manual, (2) be present when the equipment is first put into operation, (3) inspect, check, adjust as necessary, and approve the installation, (4) repeat the inspection, checking, and adjusting until all trouble or defects are corrected and the equipment installation and operation are acceptable, (5) witness and supervise operational demonstrations and system validation tests to the extent specified, and (6) prepare and submit the specified Manufacturers' Certified Report. Include all costs for representatives service in the Contract Price.

3.05 INSTALLATION

A. **Structural Fabrications.** Conform to the AISC Code and Specification references in Article "Structural Steel Fabrications."

B. **Equipment.** Conform to reviewed Instruction Manuals. Employ skilled craftsmen experienced in installation of the types of equipment specified. Use specialized tools and equipment, such as precision machinist levels, dial indicators, gauges, and micrometers, as applicable. Produce acceptable installations free of vibration or other defects.

C. **Anchor Bolts.** Deliver bolts with templates or setting drawings and verify that bolts are correctly located before structural concrete is placed.

D. **Base and Bedplate Grouting.** Do not place grout until initial fitting and alignment of connected piping is completed. Level and align equipment on the concrete foundations, then entirely fill the space under base or bedplates with grout. Bevel exposed grout at 45 degree angle, except round exposed grout at horizontal surfaces for drainage. Trowel or point exposed grout to a smooth dense finish and damp cure with burlap for three days. When grout is fully hardened, remove jacking screws and tighten nuts on anchor bolts. Check the installation for alignment and level, and perform approved corrective work as required to conform to the tolerances given in the applicable Instruction Manual.

3.06 FIELD QUALITY CONTROL

A. **General.** All costs for performing operational demonstrations and system validation tests shall be included in the Contract Price, and no extra payment will be made to the Contractor due to overtime, weekend, or holiday labor costs required to perform and complete the demonstrations and validation tests. Requirements specified in this Article are in addition to the demonstration and test requirements specified under other Sections of these Specifications.
1. **Operational Demonstration and Systems Validation Testing** shall be performed by the Contractor in accordance with the approved procedure plans to demonstrate to the District's satisfaction that:

   a) All components of the process systems defined herein, the complete systems, and the new plant systems are fully completed and operable.

   b) All units, components, systems, and the entire plant systems operate with the efficiency, repeatability, and accuracy indicated and specified.

   c) All components, systems, and the entire plant conform to the Contract Documents and the reviewed shop drawings, samples, construction manuals, materials lists, and other reviewed submittals.

2. **Scope of Demonstrations and Validation Testing.** Operational demonstrations and system validation tests are required for all work, equipment, and systems specified in these Specifications including all associated and related electrical systems and control devices.

   a) Equipment and work to be operationally demonstrated are defined as individual equipment items such as pumps, compressors, mixers, sludge collecting mechanisms, belt press and like equipment items. Demonstrations shall be performed simultaneously on groups of identical equipment items and groups of items supplied by one manufacturer to the extent feasible.

   b) Systems to be validation tested are defined as complete systems that perform a discrete process function of the plant such as chemical systems, sludge collection system, sludge dewatering system, and similar systems. Each system shall include associated structures, tanks, piping, utilities, instrumentation and controls, and like related items. Two or more separate systems shall be validation tested simultaneously when necessary to validate an entire discrete plant function.

3. **Prerequisite Conditions.** Operational demonstrations and validation testing shall not commence for any equipment item or system until all related structures, piping, electrical, instrumentation, control, and like work has been installed, tested, and connected in compliance with the pertaining requirements specified elsewhere in the Specifications.
4. **Demonstration and Testing Materials.** Furnish materials, natural gas and/or electrical power for operation demonstrations and validation tests. Use fresh water to fill tanks, wells, piping, and systems that contain water or wastewater in normal operation. Use the specified chemicals or chemical systems but do not exceed the "in service" concentrations. Furnish temporary facilities as required such as by-pass or re-circulation piping, diversions, storage, and similar facilities. Use procedures that conserve testing materials and avoid wastage, especially with respect to large quantities of fresh water and electrical power.

5. **Inspection and Supervision by Manufacturers.** Perform operational demonstrations and system validation testing under continuous inspection by the District. Technical representatives of the various equipment manufacturers shall be present at the start of the operational demonstrations, shall examine their equipment at least twice near the beginning and end of the validation tests, shall supervise the start up and adjustment procedures, and shall perform all other services necessary for the manufacturer's certified reports required herein.

6. **Correction of Defects.** Immediately correct all defects and malfunctions disclosed by demonstrations and validation tests using approved methods and new materials for repairs as required. Interruption time necessary for corrective work shall be added to the specified total demonstration and validation test periods.

7. **Acceptance.** Satisfactory completion and approval of required operational demonstrations and system validation testing is one of the conditions precedent to the District's acceptance of the work and does not constitute final acceptance. Refer to the Conditions of the Contract.

B. **System Validation Tests.** All equipment components of each system shall have successfully completed the required operational demonstration before the system is validation tested. Perform validation testing in accordance with the approved procedure plan.

1. **Test Period.** Test each system, including standby systems, by continuous operation in "in-service" condition for not less than 24 consecutive hours, with no interruptions except for normal maintenance or corrective work.

2. **Testing Methods.** Operate systems continuously 24 hours a day under constant inspection of trained operators. Cycle system operation from full load to light load and back to full load each 24 hours; cause variable speed equipment to cycle through the applicable speed range at a steady rate of change. Induce simulated alarm and distressed operating conditions, and test controls and protective devices for correct operation in adjusting system functions or causing system shutdown.
3. Simulation of Conditions. Subject to Contractor's request and District's review in each case, the Contractor may simulate certain operating conditions relating to flow rates, water levels, and malfunctions. Permission for simulations will be granted only where it is unwise or impossible to obtain the conditions covered by the capability of ranges or equipment. The simulation methods shall reflect reasonable anticipated operating conditions.


a) Flow Metering Systems shall be tested at not less than 3 values corresponding approximately to a minimum, average and maximum capacity, respectively.

b) Liquid Level Indicating Systems shall be tested at not less than 5 levels corresponding approximately to low, average, normal, maximum and high alarm levels, respectively. Low-low and high-high level alarms and system reaction shall also be tested where equipment or instruments are required to react to such conditions.

c) Remotely Controlled Valves shall demonstrate suitable operation both from local control and remote controls. As a minimum, these procedures shall include full-open and full-close positioning. Each test shall be repeated not less than 3 times for non-throttling and non-modulating valves. In addition to these minimum requirements, and subject to approval, all throttling valves and modulating valves shall be operated at not less than 3 intermediate positions and shall demonstrate the ability of each valve to hold the set position under operating conditions.

d) Variable Speed Equipment shall demonstrate accurate response to speed controlling devices and controls within the required operating ranges. Actual output shaft speeds of manually adjustable speed equipment shall be validated by measurement of shaft speeds versus speeds shown by equipment instruments.

5. Automatic Response of Equipment. Response of equipment to appropriate manual or automatic controls, or combinations of both automatic and manual controls, shall be demonstrated to be correct and accurate. Where applicable, all components shall be tested for both manual and automatic operation. Where a component performs more than one function, every function shall be validated.

a) Pumping Equipment shall respond accurately and reliably to liquid level, pressure and/or flow rate signals from appurtenant reservoirs, pipes or wet wells. Automatic alternation and back-up pump functions shall also be validated.
b) Auxiliary Equipment Items such as automatic samplers, annunciators, alarms, and like items shall respond accurately and reliably to every condition for which they are programmed, in the manner specified.

C. **Recording of Data.** Neat and comprehensive records of each operational demonstration or validation test shall be maintained by the Contractor. Each portion of the demonstration or validation procedure shall be described with all components itemized. Records shall be prepared on forms in a step-by-step fashion paralleling the approved plans. Forms shall list for each condition:

- Step taken;
- Result anticipated;
- Result obtained;
- If incorrect, corrective action taken; and
- Retest result.

The last two steps shall be repeated until all systems operate as required.

1. **Recording Devices.** Instruments, gauges, and other sensor and display devices forming a part of the various systems shall be employed for data acquisition to the extent applicable. The Contractor shall furnish all other instruments, gauges, recorders, and test devices as required, types conforming to the approved procedure plans.

2. **Information and Intervals.** All applicable data such as, but not limited to, water and other liquid levels, pressures, head differentials, duration of runs, instrument readings, chemical feed rates, voltage settings, drive speeds, motor running currents, torque, voltage, GPM, pressures, clarity, residual chlorine and related information, as applicable, and in accordance with the approved procedure plans, shall be recorded at the start and finish of every operational demonstration and at maximum 8-hour intervals during system validation tests, unless shorter intervals are specified elsewhere.

3. **Repetitions.** When a repeat of the same demonstration or validation test is required to verify the results, the repeat procedure shall be indicated on the recorded date by numerical indication, date, and time.

3.07 **CONSOLIDATION OF DEMONSTRATION, TESTING, AND INSTRUCTION REQUIREMENTS**

Operational demonstrations, system validation testing, and instruction of the District’s personnel may be performed simultaneously, subject to prior approval of the extent of consolidation in each case.
3.08  SOUND LEVEL TESTING AND WORKER PROTECTION
Measure the sound level developed by all mechanical and electrical equipment provided under the Contract Documents. Perform testing in all rooms and spaces containing such equipment during the final operation test program with all equipment operating. Use an OSHA approved instrument and record the highest sound level developed when measured according to OSHA standards in each room and space. Deliver a copy of records to the District.

3.09  IN-SERVICE CHECKS
As a part of the work, an in-service check of each system required to be validation tested shall be performed twice during the period of the Contractor's guarantee by qualified technical representatives of the various system manufacturers, including manufacturers of equipment and components within systems. Checks shall be detailed and complete, requiring not less than 8 hours at the site, and shall be performed under the observation and to the satisfaction of the District’s Plant Superintendent or his designated representative. All costs for in-service checks shall be included in the Contract Price.

A. Notification. The Plant Superintendent shall be notified in writing at least 10 days before the performance of each in-service check. The proposed dates for checking shall be changed if required by the Plant Superintendents.

B. Consultation. At the time of each in-service check, the manufacturer's technical representatives shall consult with the Plant Superintendent to review the Operation and Maintenance Manual and the pertinent operational and maintenance problems encountered, and shall furnish technical advice and recommendations to the Plant Superintendent.

C. Schedule. Initial in-service checks shall be performed approximately 6 months after final acceptance of the plant. The second in-service check shall be performed within 30 days of the end of the Contractor's guarantee period.

D. Reports. A written report of each in-service check signed by the appropriate manufacturer or his representative, shall be delivered to the Plant Superintendent within 10 days following the check. The report shall describe the checking procedure in detail, and shall state all advice and recommendations given to the Plant Superintendent.

3.10  PUMPS
This article covers general stipulations applicable to the plant pumps. All applicable parts of this Section shall also apply:

A. Equipment Testing. The purpose of equipment testing is to demonstrate that the pump units meet the specified requirements.
1. Tests shall be performed on the actual assembled unit over the entire operating range on the certified performance curve. Prototype model tests will not be acceptable.

2. All pumps 10 to 50 horsepower shall be factory-tested in accordance with the above specifications. Pumps larger than 50 horsepower may be subject to a "factory witness test" attended by a District representative. The District shall be notified at least 2 weeks in advance such that a representative can witness the pump testing. Certified test results shall be submitted to the Engineer for approval prior to shipment.

3. Pump curves shall reflect data secured during actual test runs and shall be signed by a responsible representative of the pump manufacture. Test reports and procedures shall conform to applicable requirements of the Hydraulic Institute Standards.

B. Installation. The Contractor shall install all pumping equipment in strict accordance with the manufacturer's instructions. Care shall be used in handling to avoid bumping, twisting, dropping, or otherwise damaging the equipment.

All pump manufacturers shall furnish the services of factory-trained personnel as required to examine the installation, supervise start-up of equipment installed, and repair the equipment at no additional expense to the District.

C. Field Acceptance Test. The contractor under this specification shall have full responsibility for the proper installation and performance of said pumping equipment, including furnishing the services of a pumping equipment Field Service Engineer to inspect equipment installation, and to adjust, if necessary, any portion of the pumping equipment required herein. The manufacturer’s Field Service Engineer shall assist the District in the proper conduct of pumping unit field acceptance tests. The pump units shall perform in the field as shown on the certified pump curves furnished by the Contractor. Tests shall also demonstrate operation without cavitation, vibration, overheating of moving parts, and excessive noise. The Contractor and pump manufacturer shall make necessary corrections to achieve smooth pump operation. In the event the tests reveal noncompliance of the workmanship or equipment, the Contractor shall either make alterations as necessary or replace the pumps in order to meet the requirements of the specifications at no additional cost to the District.

D. CERTIFICATION OF INSTALLATION. The Contractor shall submit a letter to the District confirming that all pumping equipment was inspected, operation checked, and installation approved in writing by the respective pumping equipment supplier.
E. **WARRANTY.** All pumping equipment shall carry an extended warranty for a two year period from the date of acceptance. All warranties shall be turned into the District prior to project completion.

F. **MAINTENANCE BOND FOR PUMPING EQUIPMENT.** The contractor or his supplier shall provide a maintenance bond (EMWD Standard form C-14 or C-14.1) from a bonding company acceptable to the District equal to 100% of the pumping equipment value (including motors, pumps and pump assemblies) for a two (2) year term starting when the District has accepted the contracted work. Equipment and/or components failing within this period due to deficiency in design, workmanship or material shall be removed, replaced, and reinstalled at no cost to the District, and said replacement shall be guaranteed for two years continuous service. The maintenance bond shall be submitted to the District prior to the performance test of the pump(s).

3.11 **EARTHQUAKE DESIGN AND RESTRAINT**

All manufacturer equipment supplied under this Contract shall be designed, constructed and attached to resist stresses produced by seismic forces specified in this Section. Equipment that does not vibrate during normal operation shall be rigidly attached. Equipment that vibrates during normal operation shall be attached by means of isolators with mechanical stops that limit movement in all directions unless it can be demonstrated by calculations that such stops are not required. Equipment or portions of equipment that move during normal operation shall be restrained with mechanical devices that prevent displacement unless it can be demonstrated by calculations that such restraints are not required.

A. **Work Included.** The work included in this Paragraph includes, but is not limited to, the following equipment items:

1. Pipe supports and hangers.
2. Electrical control panels.

B. **Minimum Earthquake Forces.** The minimum earthquake forces shall be those prescribed for Essential Facilities by the Uniform Building Code and applicable supplements as published by the International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90601, or as specified in the "Soil Investigation Report," whichever is greater.

Contractor shall submit shop drawings, details and data herein before specified in Section F General Conditions, F-30, "Submittals."

**END OF SECTION 11005**
[PAGE LEFT INTENTIONALLY BLANK]
PART 1 - GENERAL

1.01 DESCRIPTION

Contractor shall provide two (2) submersible, non-clog raw sewage pumps, complete with vertical submersible AC motor and power/control cables, as specified herein and shown on the Drawings. Pumping equipment shall be suitable for installation in a wet well configuration. Equipment shall include pumps, motors, bases, and all necessary appurtenances to form complete pumping units. Contractor shall review the pre-negotiated proposal from the pre-selected equipment supplier and determine/ensure that Contractor’s project bid price includes all equipment and appurtenances necessary for a complete system.

1.02 SPECIFIC PUMPING UNIT REQUIREMENTS

A. General

Furnish and install two (2) submersible non-clog sewage pumps complete with pump, motor, pump base, and associated appurtenances. Each pumping unit shall be operated by an across-the-line (full voltage) motor starter.

B. Size and Capacity

Each pumping unit shall be designed and constructed to satisfactorily meet the following performance characteristics:

<table>
<thead>
<tr>
<th>Capacity (gpm)</th>
<th>Discharge Capacity</th>
<th>Total Dynamic Head (ft)</th>
<th>Minimum Hydraulic Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>64</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>53±2</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>130*</td>
<td>40</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>29±3</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>240</td>
<td>15±3</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

*Design condition with one pump operating.
Pump shall be Flygt Model NP (no substitutes). Preliminary pump selection is Flygt Model NP-3069-SH Adaptive 275 with 4.53 inch (115 millimeter) diameter impeller (no trim). Manufacturer shall confirm preliminary pump selection, including impeller size.

2. The pump shall have a maximum NPSHR of 14.5 feet at 240 gpm. The pump shall be suitable to operate at this minimum NPSH without cavitation or damage.


4. Minimum motor horsepower - 2.7 (no point on pump performance curve shall exceed motor horsepower).

5. Pump discharge connection shall be a minimum of 2-9/16 inch diameter (3\" nominal).

6. Pumping unit shall be capable of passing a minimum 2.56 inch (65 millimeter) diameter solid.

7. 460 volt, 3 phase supply power.

8. Pumping unit shall be capable of continuous operation either partially or fully submersed in pumped liquid of up to 30 foot depth.

1.03 SUBMITTALS

A. Shop Drawings

In accordance with the requirements of the General Conditions, Section F – Labor and Construction, Contractor shall submit complete information, drawings, and technical data for all equipment and components, including, but not limited to, the following:

1. Type and model number with reference to pump's suitability for service for raw sewage and pump's specific intended use.

2. Assembly drawing, nomenclature, and material list.

3. Type, manufacturer, model numbers, location, and spacing of bearings.
4. Impeller diameter, maximum solid sphere size, number of vanes, and identification number.

5. Complete performance curves for full speed operation. Performance curves shall indicate total dynamic head, flow rate, brake horsepower, shutoff head, net positive suction head required, rpm, and efficiency.

The manufacturer shall indicate by arrows to points on the H/Q curves on the limits recommended for stable operation, between which pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible and shall be based on actual hydraulic and mechanical characteristics of the units.

Provide certified performance curves prior to shipment.

6. Minimum water surface required for operation without cavitation.

7. Minimum water surface required for continuous operation.

8. Motor data, including the manufacturer, size, type designation, minimum guaranteed efficiency and power factor at full load, 3/4 load, and 1/2 load, locked motor current in amps, full load current in amps, and motor full load speed in rpm.

9. Curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.

10. Wiring diagrams for motor and motor sensors.

11. Technical data for motor cables, including motor power cable(s) and motor sensor (cables).

12. Anchor bolt size, placement, and any additional details required for proper installation of pumping units, and associated equipment.

13. Outline dimensions and weights of pumps, bases, motors, and control enclosures.

14. Materials of pump construction, including shafts, bearings, impellers, castings, and pump base.
15. Interior and exterior protective coatings.

16. Installation instructions.

B. **Operation and Maintenance Manuals**

Operation and maintenance manuals shall be provided in accordance with the requirements of the General Conditions, Section F – Labor and Construction, and Detailed Provisions, Specification Section 01430.1.

1.04 **QUALITY**

A. All pumping equipment furnished under this Section shall be of a design and manufacturer that has been used in similar applications. Manufacturer shall demonstrate to the satisfaction of the Owner that pumps of similar construction are in service and functioning properly. Manufacturers, as specified herein, manufacture pumping units with acceptable quality or experience. Manufacturers must, however, meet the performance requirements stated herein for the actual pumps specified. Listing of said manufacturers does not imply that said performance requirements can be met for each pumping unit specified. Contractor shall be responsible to verify that manufacturers supplying equipment meet the size and capacity requirement specified herein.

B. Pump manufacturer shall verify applicability of pumping equipment with respect to wet well configuration and mounting, NPSHA and wet well water levels to assure prevention of cavitation, vibration, clogging, surging, and overheating.

1.05 **PUMP WARRANTY**

The pump manufacturer shall warranty each pump being supplied to the Owner against defects in workmanship and materials for a period of two (2) years from the date of project acceptance. The warranty shall be in printed form and included in the operation and maintenance manuals.

1.06 **MAINTENANCE BOND FOR PUMPING EQUIPMENT**

The supplier shall provide a maintenance bond (see C-14) from a bonding company acceptable to the District equal to 100 percent of the pumping equipment value (including motors, pumps, and pump assemblies) for a two (2) year term starting when the District has accepted the contracted work. Equipment and/or components failing
within this period due to deficiency in design, workmanship, or materials shall be removed, replaced, and reinstalled at no cost to the District, and said replacement shall be guaranteed for two years continuous service from the date of replacement. The maintenance bond shall be submitted to the District prior to the field performance test of the pump(s).

PART 2 - PRODUCTS

2.01 PUMPS

A. Design Configuration

Pump shall be capable of operating in a continuously in a partially or full submerged condition in a vertical position in a wet pit installation, single suction, centrifugal type, and semi-permanent connection to discharge elbow.

B. Pump Construction

1. Major pump components shall be constructed of grey cast iron, ASTM A-48, Class 30B, with smooth surfaces devoid of blow holes or other irregularities. The lifting handle shall be constructed of stainless steel. All exposed nuts or bolts shall be constructed of Type 304 stainless steel or brass. All interior ferrous metal surfaces coming into contact with the pumpage shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish. All exterior ferrous metal surfaces shall be provided with a factory applied spray coating of acrylic dispersion zinc phosphate primer and a polyester resin finish coat.

2. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber O-rings. Fitted mating surfaces shall be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression will not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.
C.  Impeller

1. The impeller shall be constructed of “hard-iron” (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back-swept, screw-shaped, non-clog design. The impeller vane leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on a replaceable insert ring.

2. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of sludge and rag-laden wastewater. The impeller shall be capable of momentarily moving axially upwards a distance of 0.4 inches to allow larger debris to pass through and immediately return to normal operating position.

3. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft and held by an impeller bolt. The impeller shall be coated with alkyd resin primer.

D. Volute/Suction Cover

1. The pump volute shall be a single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified or as shown on the Drawings.

2. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The insert ring shall be cast of “hard-iron” (ASTM A-532 (Alloy III A) 25% chrome cast iron) and shall provide effective sealing between the multi-vane semi-open impeller and the volute housing.

E. Pump Shaft

1. The pump and motor shaft shall be a single piece unit. The pump shaft shall be an extension of the motor shaft.
2. The shaft shall be constructed of stainless steel (ASTM A479, S43100-T).

3. Shafts using mechanical couplings or sleeves will not be acceptable.

F. **Bearings**

1. The integral pump/motor shaft shall rotate on two bearings. The motor bearings shall be sealed and shall be permanently grease lubricated with high temperature grease. The upper and lower motor bearing assemblies shall be a single row shielded ball bearings.

2. Sleeve bearings will not be acceptable.

G. **Mechanical Seals**

1. Each pump shall be equipped with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal shall be corrosion resistant tungsten-carbide/tungsten-carbide. The upper seal shall be carbon/ceramic.

2. Each seal interface shall be held in place by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The position of both mechanical seals shall depend on the shaft. Mounting of the lower mechanical seal on the impeller hub will not be acceptable.

3. The following seal types will not be considered acceptable or equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. In addition, no system requiring a pressure differential to offset pressure and to affect sealing will be acceptable.

4. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug with positive anti-leak seals that are easily accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for...
lubrication. The motor shall be able to operate dry without damage while pumping under load.

5. The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

6. A separate seal leakage chamber shall be provided so that any leakage that may occur past the upper, secondary mechanical seal will be captured prior to entry into the motor stator housing. Such seal leakage shall not contaminate the motor lower bearing. The leakage chamber shall be equipped with a float type switch to detect the presence of water.

H. Motor

1. Motor horsepower shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a minimum depth of 65 feet.

2. The pump motor shall be a submersible, explosion-proof design, approved by Factory Mutual in Class I, Groups C and D, hazardous locations. The motor shall be 460V, 3 phase, high efficiency, NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The motor service factor shall be 1.10, minimum. The motor shall have a voltage tolerance of +/- 10%. The motor shall be designed for continuous operation in up to a 40°C ambient and shall have a NEMA Class B maximum operating temperature rise of 80°C. The stator windings shall be insulated with moisture resistant Class F insulation rated for 155°C (311°F).

3. The stator shall be dipped and baked three times in Class F varnish and shall be cold pressed into the stator housing. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable.
4. The motor shall be designed for continuous duty while handling pumped media of up to 104°F. The motor shall be capable of no less than 15 evenly spaced starts per hour.

5. The rotor bars and short circuit rings shall be constructed of aluminum. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the motor control panel or motor control center.

6. The power and control cable(s) shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the above grade junction box without the need of any splices. The outer jacket of the cable(s) shall be oil resistant chlorinated polyethylene rubber. A minimum of 6’ of additional cable length shall be furnished for coiling inside the wet well. Contractor shall coordinate with the pump manufacturer to determine the minimum required length of cable(s) for each pumping unit.

I. Cooling System

1. Motors shall be adequately cooled by the surrounding environment or pumped media.

2. Motors requiring a water cooling jacket will not be acceptable.

J. Cable Entry Seal

1. The cable entry seal assembly shall be designed to insure a watertight and submersible seal. The cable entry shall consist of single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function.

2. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top.
K. Protection

1. Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. The thermal switches shall open at 260°F (125°C).

2. A float switch shall be installed in the seal leakage chamber and shall activate when the presence of water is detected in the stator chamber.

3. The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in any control panel.

L. Nameplates

The pump shall have a Type 316 stainless steel plate permanently attached by stainless steel screws or rivets to the pump frame into which the following information shall be impressed, engraved, or embossed: manufacturer's name, pump size, serial number, impeller diameter, capacity, head rating, speed, and bearing numbers. Nameplates shall also include information unique to each item of equipment and device to identify its function as described herein. Function nameplates shall be approximately one inch by three inches if made separately. Letters of function titles shall be not smaller than 1/4 inch high.

M. External Hardware

All external nuts, bolts, and washers, etc. shall be Type 316 stainless steel.

2.02 PUMP SPARE PARTS

A. General

Contractor shall furnish spare parts and lubricants for each pumping unit specified herein. Spare parts and lubricants shall be as specified herein or as recommended by the manufacturer shall be undamaged and packaged in original containers and supplied to the Owner at time of final acceptance of the Work.
B. **Spare Parts and Lubricants**

Contractor shall furnish the following spare parts for each pump:

1. Two (2) spare sets of cable entry assembly parts, including plain washer, seal sleeve, and cable clip.
2. One (1) spare set of mechanical seals.

PART 3 - EXECUTION

3.01 INSTALLATION AND STARTUP

Pump manufacturer or supplier of the equipment furnished under this Section shall furnish the services of competent factory-trained personnel to provide technical assistance for installation and startup of the pumps. Costs for same shall be included in the price bid.

3.02 CERTIFICATION OF PROPER INSTALLATION

The Contractor shall submit to the Owner written certification (Exhibit B herein) from the equipment manufacturer's authorized representative certifying that all furnished equipment has been installed, inspected, checked, adjusted, and tested in accordance with the manufacturer's recommendations and requirements specified herein.

3.03 INSTRUCTION

After the equipment has been installed, started up, tested, and adjusted, Contractor shall provide the services of a manufacturer's representative to instruct the Owner's operations personnel in the use and maintenance of the equipment. Two (2) hours of instruction shall be provided, unless otherwise specified. The manufacturer shall provide a level of instruction which is adequate to train the Owner's personnel regarding use of the equipment. During this instruction period, it shall be the responsibility of the manufacturer to answer any questions from the Owner's operating personnel. Cost for this instruction shall be included in the price bid.
3.04 EQUIPMENT TESTING

A. General

Equipment shall be shop tested and field tested as specified hereinafter.

The Contractor shall submit the complete factory test procedures to the Owner for approval at least 30 days prior to the shop test.

In the event any equipment fails to meet the Specifications, it shall be modified and retested in accordance with these Specifications.

B. Factory Tests

Each pump and motor shall be factory (shop) tested as specified hereinafter; all pumps shall be tested with motor and cables being furnished with the pumps. The Contractor shall submit the complete pump test procedure, a diagram of the test setup showing location of instruments, a sample of the test stand log sheet, and calibration data of all instruments and measuring devices to be used by the manufacturer to the Owner, for approval, prior to the pump tests. Six copies of certified test reports, including actual test records, and certified pump performance curves shall be submitted and approved by the Owner prior to shipment of the equipment.

Pumps shall be tested for performance at the factory to determine head versus capacity, efficiency, and brake horsepower required for the maximum speed at which the pumps are proposed to operate. Test shall include multiple operating conditions (minimum 4 points on curve) to show pump's ability to operate at full range specified and presented on the manufacturer's initial performance curve. Tests of models, prototypes, or similar units will not be acceptable. All tests shall be run in accordance with the test code for centrifugal pumps of the Standards of Hydraulic Institute, latest edition. The motor and cable on each pump shall be tested for moisture content or insulation defects. After the test, the pump cable end shall be fitted with a shrink fit rubber boot to protect it from moisture or water. All costs for factory test shall be included in the price bid.

C. Field Tests

The Contractor shall perform field tests to demonstrate pump performance. Equipment shall be field tested as specified hereinafter.
The Contractor shall provide flow meter, vibration meter, tachometer, calibrated pressure gauges, volt meter, amp meter, power monitor, and other equipment required to perform field tests. Contractor shall record all field measurements.

Field tests shall be performed to demonstrate that the pumping units, motors, and control system meet the following requirements:

1. The pumping units operate as specified without excessive noise, surging, cavitation, vortexing, vibration, or clogging, and without overheating of the bearings. Each pumping unit shall operate a minimum of 30 minutes. Pump vibration shall be measured and recorded. The vibration shall not exceed the amplitude limits recommended by the Hydraulic Institute Standards. As a minimum, vibration shall be recorded at 4 pumping conditions defined by the Owner.

2. Pumping units shall perform in the field as shown on the certified pump curves and as specified herein. Pump performance shall be documented by obtaining concurrent readings showing pump flow rate, pump suction and discharge head, pump rpm, and motor voltage, amperage, power factor, and kW. Readings shall be documented at a minimum of three pumping conditions, including the specified design point. Another test shall be run at shut-off head. Each power lead to the motor shall be checked for proper balance.

3. All automatic and manual controls function in accordance with the specified requirements.

Testing shall be performed utilizing raw sewage. Discharge valves shall be throttled to simulate various discharge head conditions.

In the event any of the pumping equipment fails to meet the above test requirements, it shall be modified and retested in accordance with the requirements of these Specifications. All cost of retesting, including costs of travel expenses and witnessing, shall be borne by the Contractor.
Upon completion of field testing, Contractor shall prepare a report documenting all field measurements, presenting field test results (pump head versus capacity curve, pump efficiency curve, and brake horsepower curve), and providing a comparison of the field test results to the manufacturer's factory test results. Contractor shall submit six (6) copies of the field test report to the Owner for approval.

END OF SECTION
MANUFACTURER’S CERTIFICATE OF PROPER INSTALLATION

OWNER: ________________________________  EQPT SERIAL NO: ________________________________

EQPT TAG NO: __________________________  EQPT/SYSTEM: ________________________________

PROJECT NO: ___________________________  SPEC. SECTION: ________________________________

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

(Check Applicable)

☐ Installed in accordance with Manufacturer’s recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

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

Comments: ________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

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

Date: ________________________________

Manufacturer: ________________________________________________________________

By Manufacturer’s Authorized Representative: ____________________________________

(Authorized Signature)
PART 1 - GENERAL

1.01 GENERAL

A. The Contractor shall fabricate, install, test, and leave ready for operation one (1) stationary standby power diesel engine generator set complete with sound attenuated weatherproof enclosure, sub-base fuel storage tank, and all appurtenances, as specified herein and shown on the Drawings. Where specific project requirements stipulate, generator set shall be provided with a diesel particulate filter (DPF) system and/or load bank system. DPF and load bank systems shall be in accordance with the requirements specified herein and shown on the Drawings.

B. The generator set shall be a complete and operable emergency standby power system capable of providing electrical power during periods of failure of the normal utility power supply.

C. The generator set shall be minimum capacity specified and be suitably sized to provide electric power necessary to start and operate all motor loads and low voltage transformer loads as specified herein.

D. Generator set shall automatically start via signal from automatic transfer switch at the facility.

1.02 SPECIFIC PROJECT GENERATOR SET REQUIREMENTS

This section provides specific details regarding generator sets, which shall modify specified requirements in Part 2, herein. All requirements in Part 2 not modified by this section shall apply.

A. Contractor shall furnish and install one (1) stationary standby power diesel engine driven generator set as specified herein and shown on the Drawings.

B. The generator set shall have a full load rated standby power capacity of not less than 40 kW at 0.80 power factor, at conditions of service specified in Part 1.06 herein.
C. The generator set shall be rated 277/480 volt (reconnectable), 3-phase, 4 wire, 60 Hz.

D. The unit shall be capable of operating loads specified in Part 1.06 herein, with a maximum allowable instantaneous voltage dip of 20 percent. A unit larger than 40 kW shall be furnished if necessary to operate specified loads.

E. The sub-base fuel storage tank shall have sufficient capacity to allow continuous operation of the generator set for a minimum of 24 hours at 100% of full-rated load. The sub-base fuel storage tank shall have a minimum useable capacity of 90 gallons.

F. The generator set shall be provided with a load bank system. A DPF system is not required.

G. The generator set shall be provided with an alternator space heater.

H. The generator set shall be provided with a continuous diesel fuel level monitoring system.

1.03 RELATED SECTIONS

A. The Contract Documents are a single integrated document, and as such all Specification Sections apply. It is the responsibility of the Contractor and its subcontractors to review all Sections and ensure a complete and coordinated project.

B. Related Specification Sections include, but are not limited to, the following:

1. Division 1 – General Requirements
2. Division 11 – Equipment
3. Division 15 – Mechanical
4. Division 16 – Electrical
5. Division 17 – Instrumentation and Controls

1.04 STANDARDS AND CODES

A. Equipment and materials, including installation of same, shall meet or exceed
the applicable requirements of the following standards and codes (latest edition):

1. California Building Standards Commission, California Code of Regulations
   - Title 24, Part 9 California Fire Code

2. International Electrotechnical Commission (IEC)
   - IEC 60034-1 Rotating Electrical Machines - Part 1: Rating and Performance

3. International Standardization Organization (ISO)
   - ISO 3046 Reciprocating Internal Combustion Engines
   - ISO 8528 Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets

4. National Electrical Manufacturers Association (NEMA)
   - NEMA MG1 Motors and Generators
   - NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches
   - NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

5. National Fire Protection Association (NFPA)
   - NFPA 30 Flammable and Combustible Liquids Code
   - NFPA 37 Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
   - NFPA 70 National Electrical Code
   - NFPA 110 Standard for Emergency and Standby Power Systems
6. **Underwriters Laboratories (UL)**

- **UL 142** Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids
- **UL 489** Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
- **UL 508A** Standard for Industrial Control Equipment
- **UL 2200** Standard for Stationary Engine Generator Assemblies

**B.** All materials and equipment, and the design, construction, and installation thereof, shall comply with all applicable provisions of the Federal Occupational Safety and Health Administration (OSHA), and California Occupational Safety and Health Administration (Cal OSHA).

**C.** Where the Drawings or these Specifications call for material, equipment and workmanship to be of better quality or higher standard than required by the above standards and codes, and applicable rules and regulations, then said Drawings and Specifications shall prevail. Nothing on the Drawings or in these Specifications shall be construed to permit work in violation of the above standards and codes.

**D.** In the event of a conflict or disagreement between the Drawings and Specifications; and standards; codes; federal, state, and local laws and ordinances; or industry standards; the most stringent requirements shall govern. The Contractor shall promptly notify the District in writing of such differences.

1.05 **CONTRACTOR SUBMITTALS**

**A. Shop Drawings/Submittals**

Contractor shall prepare and submit shop drawings/submittals for all generator set equipment and materials to be furnished by the supplier for review and acceptance by District prior to fabrication and delivery. Shop drawings/submittals shall be provided in accordance with the District's General Conditions, Section F–Labor and Construction.

Shop drawings/submittals shall show the ratings, performance data, dimensions, weights, materials of construction and other relevant details of the generator set equipment and material to be furnished. Manufacturer product literature and
specifications shall be marked to clearly identify all applicable information and crossing out inapplicable information. Applicable sizes, model numbers, and options shall be clearly marked. Sufficient data and details shall be provided to demonstrate compliance with these Specifications and the Construction Drawings.

As a minimum, shop drawings/submittals shall include the following information:

1. Detailed Bill of Materials for all generator set equipment, materials, and components, listing: quantity, manufacturer's name, description, and catalog/part number.

2. Manufacturer catalog cut sheets, specification sheets, technical data, illustrations, diagrams, etc. for all generator set equipment and components indicating sizes, ratings, performance capabilities, operating parameters and recommended ranges, materials of construction, standard features, options, accessories, etc.

3. Manufacturer's statement of exhaust emissions and emission performance data for the proposed generator set. Exhaust emission test parameters and measurements shall be in accordance with EPA protocol.

4. Detailed shop drawings of generator set and enclosure layout (plan and elevation views), including alternator, engine, exhaust silencer and outlet, diesel particulate filter system (where specified), load bank system (where specified), fuel tank, fuel and air filters, generator set control panel, battery charger, batteries, electrical connections, piping connections, access openings, air louvers, and associated equipment.

5. Design calculations and recommendations, including, but not limited to: generator set size selection, sub-base fuel storage tank sizing, sub-base fuel storage tank normal and emergency vent sizing, normal vent piping back pressure, emergency vent piping back pressure (where specified), exhaust system sizing, and exhaust system back pressure.

6. Dimensional drawings for generator set, including sound attenuated enclosure and sub-base fuel tank showing locations and requirements for all external connections and mountings/supports. Dimensional drawings for sub-base fuel tank showing locations and sizes of all tank fittings, lift eyes, and mounting holes.

7. Weights and center of gravity of all equipment (dry and operating).
8. Complete information and data for vibration isolators provided between alternator/engine base frame and sub-base fuel tank.

9. Equipment seismic restraint and anchorage calculations prepared by a registered professional civil or structural engineer in the State of California. Calculations shall be prepared in accordance with the California Building Code (latest edition) for Occupancy/Risk Category IV Facilities with Seismic Importance Factor = 1.5. Safety factor for overturning shall be 1.5:1. Calculations shall be based on project specific seismic design parameters, which are provided in the Specification Special Conditions or Special Requirements.

10. Complete information, drawings, schematics, diagrams, and technical data for the generator set control panel, including all instrumentation and components. Control panel schematic diagram (block diagram) shall show all panel components and interconnections. Control panel wiring diagram shall show wiring for internal components and terminal strip(s) for landing all external connections (power, instrument cables, signals, control, etc.).

11. Certification of two-year free subscription for computer software to interface with the control panel and engine electronic control module, including software updates.

12. Complete information, drawings, schematics, diagrams, and technical data for DPF emissions monitoring controller (where specified), including all instrumentation and components. Controller schematic diagram (block diagram) shall show all DPF system components and interconnections. Controller wiring diagram shall show wiring for internal components and terminal strip(s) for landing all external connections (power, instrument cables, signals, control, etc.).

13. Complete information, drawings, schematics, diagrams, and technical data for load bank system (where specified), including all instrumentation and components. Load bank control panel schematic diagram (block diagram) shall show all load bank system operation, safety circuits, associated components and interconnections. Load bank control panel wiring diagram shall show wiring for internal components and terminal strip(s) for landing all external connections (power, instrument cables, signals, control, etc.). Overcurrent protection and control devices shall be identified and their ratings marked. Load bus configuration and load
connection termination area shall be clearly identified. In addition, an interconnection drawing shall be provided for all instrumentation and control wiring related to the load bank.

14. Detailed instructions for unloading, handling, storage, and installation, including mounting and connection procedures for all mechanical and electrical equipment.

B. Operation and Maintenance Manual

Contractor shall prepare and submit a complete and organized operation and maintenance (O&M) manual in accordance with the General Conditions, Section F - Labor and Construction, and Detailed Provisions, Specification Section 01430.1. As a minimum, the O&M manual shall include the following information:

1. Equipment Information, Performance Data, and Drawings
   a. Detailed Bill of Materials for all generator set equipment, materials, and components, listing: quantity, manufacturer's name, description, and catalog/part number.
   b. Manufacturer catalog cut sheets, specification sheets, technical data, illustrations, diagrams, etc. for all generator set equipment and components indicating sizes, ratings, performance capabilities, operating parameters and recommended ranges, materials of construction, standard features, options, accessories, etc.
   c. As-built shop drawings for all equipment and components, including fabrication and assembly drawings, panel drawings, wiring diagrams, and schematics. Electrical wiring diagrams and schematics shall also be provided for all interconnecting power and signal wiring between equipment, instrumentation, and control devices.

2. Equipment Unloading, Storage, and Installation Requirements
   a. Unloading, handling, and long-term storage requirements.
   b. Complete, detailed installation instructions for each equipment and component item.
3. **Equipment System Operation**
   
a. Complete, detailed equipment pre-startup and pre-energization instructions and checklists.
   
b. Complete, detailed operating instructions for each equipment and component item, including system startup and shutdown procedures and sequence.
   
c. Safety provisions and precautions, including explanations for all safety considerations relating to operations and maintenance, and protective equipment and clothing requirements for same.

4. **Equipment Service and Maintenance Data**
   
a. Maintenance data shall include all information and instructions required by District's personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions properly throughout its full design life.
   
b. Recommended schedule of maintenance tasks.
   
c. Lubrication charts and tables of alternate lubricants.
   
d. Details of calibration and adjustment
   
e. Alarms and troubleshooting instructions.
   
f. Name, address and phone number of manufacturer and manufacturer's local service representative.

5. **User Manuals**
   
a. User manuals and application guides for all microprocessor based equipment and accessories, including but not limited to: genset control panel controller and operator interface, load bank control panel controller (if applicable), and DPF system control panel controller (if applicable).

6. **Equipment Warranties**
C. Shop Service and Parts Manuals

Contractor shall provide complete and organized shop service and parts manuals for the standby generator set. Contractor shall submit one (1) electronic (searchable PDF format) copy of the shop service and parts manuals. The shop service manuals shall address testing, adjusting, troubleshooting, disassembling and assembling of all engine components. System schematics and detailed technical descriptions of systems theory shall also be included in the service manuals. In addition, complete parts manuals shall be provided, including drawings (blowup drawings preferred) with lists of part numbers (serial numbers), descriptions, quantities, and ratings/sizes.

1.06 CONDITIONS OF SERVICE

A. The generator set shall be capable of operation under any combination of the following conditions without mechanical or electric damage.

- Ambient Temperature: 0°F to 120°F
- Relative Humidity: 10% to 90%
- Altitude: 1,500 Ft.
- Air Supply: From Outside

B. The generator set shall be capable of starting and operating each of the following loads. Generator set manufacturer shall submit generator sizing calculations and confirm generator size based on equipment furnished and existing equipment (if applicable). Use actual equipment motor performance for generator sizing (SKVA and FLA). The generator set shall be connected to start all the loads in the sequence specified herein. Unless specified otherwise, all equipment is 460 volt, 3 phase, 60 Hz with across the line full voltage start.

C. Step 1 - Start the following equipment simultaneously:

1. One (1) 7.5 KVA low voltage transformer and lighting panel (120 volt), 1.00 power factor.
2. One (1) 20 KVA low voltage transformer and lighting panel (120/240 volt), 1.00 power factor.
3. One (1) submersible sewage pump with 3 hp, 3,600 RPM, 460 volt, 3 phase motor with across-the-line starter.
D. **Step 2** - With Step 1 loads running, start the following equipment:

1. One (1) submersible sewage pump with 3 hp, 3,600 RPM, 460 volt, 3 phase motor with across-the-line starter.

1.07 **QUALITY ASSURANCE**

A. All materials, equipment, and parts of the standby generator shall be new and unused, of current manufacture, of highest grade, and assembled in a workmanlike manner. The generator set shall be factory assembled, tested by the engine manufacturer, and shipped to the job site by his authorized distributor having a parts and service facility in the local area. The generator set shall be as manufactured by Olympian (supported by Caterpillar), Caterpillar, Cummins, or Generac (no substitutes).

B. Standby generator set shall be provided with an extended warrantees against defective parts or workmanship under the terms of the manufacturer's/supplier's standard warranty for a total of two (2) years from date of project acceptance, and shall cover full parts and labor.

1.08 **PERMITS AND REQUIREMENTS FOR SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)**

A. Permits to construct and to operate are required from the SCAQMD for the emergency standby generator set. The emergency standby power system shall conform to all requirements of SCAQMD for standby generators. Manufacturer shall equip the generator set with the necessary devices to meet the current SCAQMD regulations for the operation of a diesel emergency standby generator. Generator set shall be "pre-certified"/"pre-approved" by SCAQMD for emergency standby power service. Generator set shall have the highest available tier rating, in accordance with EPA Tier Certification Requirements.

B. Contractor shall coordinate with the manufacturer to obtain engine data for the proposed generator set, and shall be responsible for providing all engine data required as part of the SCAQMD permit process. Contractor shall provide District with application form for SCAQMD Permit to Construct and Operate, including provision for a minimum of 12 hours per month of maintenance operation. Application form shall be complete except for District information and signature. District shall execute application and submit same to SCAQMD for approval, along with all required permit fees.
1.09 SAFETY

A. All equipment furnished under these Specifications shall comply with the safety orders of local, state, and federal governing bodies. All rotating components such as drive shafts, couplings, flywheel, and vee-belts that will be exposed to District's Operations personnel shall be enclosed in solid, sheet metal safety enclosures in compliance with said safety orders.

B. Heat protective devices shall be installed where necessary to protect personnel from accidental contact with any parts of the engine exhaust system during the performance of normal generator set operation or maintenance functions. Heat protective devices shall comply with OSHA standards, and may include metal screen protectors or insulation. Insulation shall be designed and fabricated for easy removal and provided with environmental coverings suitable for the location and exposure.

PART 2 - PRODUCTS

2.01 ENGINE

A. Engine shall be diesel, four-cycle, 1,800 rpm (maximum), liquid-cooled, and turbocharged and after-cooled (air-to-air). The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the generator and all connected accessories when operating on No. 2 domestic burner oil. Diesel engines requiring premium fuels will not be considered. Two-cycle engines are not acceptable. The engine shall be manufactured by Caterpillar, Cummins, John Deere, Mitsubishi, Perkins, Fiat Power Technologies (FPT), or Generac; no substitutes.

B. The engine-generator set shall be mounted on a heavy duty torsionally stiff structural steel frame (skid) to maintain proper alignment between components. Frame shall be fabricated from channel or I-beam to ensure adequate mounting surface contact and minimal deflection.

C. The generator set shall be equipped with a skid-mounted, engine-driven radiator with blower fan, coolant pump, and all accessories. The cooling system shall be sized to operate at full rated load and 120°F ambient air entering the generator unit enclosure. The cooling system shall be filled with ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact per CalOSHA requirements. The generator set supplier shall be responsible for providing a properly sized cooling system based on the
generator unit enclosure static pressure restriction.

D. A DC electric starting system with positive engagement shall be furnished. The starting motor voltage shall be as recommended by the engine manufacturer. The electric starter shall be capable of a minimum of three complete cranking cycles without overheating.

E. As a minimum, the engine shall be provided with the following components and features:

1. Positive displacement, mechanical, full pressure, lubrication oil pump.

2. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

3. An engine driven, mechanical, positive displacement fuel pump.

4. Replaceable dry element air cleaner with restriction indicator.

5. Engine mounted battery charging alternator and solid-state voltage and current regulator.

F. Provide electronic governor consisting of a magnetic pickup speed sensor, adjustable electronic control, and an actuator mounted with the fuel pump. Governor shall provide automatic isochronous generator set frequency control.

G. Performance, materials, and workmanship shall be in accordance with Diesel Engineer Manufacturer's Association standard practices.

2.02 ENGINE FUEL SYSTEM

A. The diesel fuel system shall consist of an engine-driven fuel supply pump, fuel line check valve, fuel filters, and secondary containment (double walled) sub-base fuel storage tank. The main fuel pump on the engine shall be capable of supplying fuel directly from the sub-base storage tank without the need for an intermediate pump.

B. The fuel filters shall be skid mounted and shall be the combination fuel filter/water separator type. Elements shall be easily replaced without breaking any fuel line connections, disturbing the fuel pumps or any other part of the engine. All fuel filters shall be conveniently located ahead of the injection or circulating pump so that the fuel shall be thoroughly filtered before it reaches
The injectors. No screens or filters requiring cleaning or replacement shall be used in the injection or circulating pump, or in the injection valve assemblies.

C. The secondary containment fuel storage tank shall be constructed of 12 gauge (minimum) carbon steel, have inner and outer walls with an interstitial space (annulus) between the walls, and be provided with a means for monitoring the interstitial space for a leak. The fuel storage tank shall be an atmospheric tank, designed and constructed in accordance with NFPA 30 and UL 142. The fuel storage tank shall be suitable to operate at pressures from atmospheric to 0.5 psi (minimum) gauge pressure, 2.5 psi gauge pressure under emergency venting conditions, and 3 psi to 5 psi gauge pressure under test conditions. The fuel storage tank shall be UL listed, and shall meet all state and federal requirements for aboveground diesel fuel storage tanks, including design, fabrication, and installation. The fabricated fuel storage tank shall be factory tested to between 3 psi and 5 psi in accordance with UL testing requirements.

D. The fuel storage tank shall be furnished as a complete, factory fabricated, assembled, and tested assembly and listed as an assembly by UL under UL 142. The primary and secondary containment tanks shall be of rectangular configuration. The secondary containment tank volume shall be 110% of the primary tank. The interior of the primary tank shall be cleaned and free of any mill scale, loose material, or debris. The fuel storage tank assembly shall be suitable for mounting to a concrete foundation over a non-shrink grout pad (1/2" +/- thick) and continuous beneath storage tank bearing surfaces.

E. The primary and secondary portions of the fuel storage tank shall not encroach upon the electrical stub-up area for conduit, including conduit for all power, control, and signal conductors and cables. As a minimum, the sub-base fuel storage tank shall be provided with the following connections, components, and options:

1. One (1) top mounted FNPT fuel supply connection in primary space (size per generator set manufacturer)
2. One (1) top mounted FNPT fuel return connection in primary space (size per generator set manufacturer)
3. One (1) top mounted 2" FNPT fuel fill connection in primary space
4. One (1) top mounted 2" FNPT normal vent connection in primary space
5. One (1) top mounted 2" FNPT mechanical fuel level gauge connection in primary space
6. One (1) top mounted 2" FNPT analog fuel level monitoring connection in primary space
7. One (1) top mounted 2" FNPT low fuel level warning connection in
primary space

8. One (1) top mounted 2" FNPT spare connection in primary space
9. One (1) top mounted FNPT emergency vent connection in primary space (size per generator set manufacturer)
10. One (1) top mounted FNPT emergency vent connection in secondary space (size per generator set manufacturer)
11. One (1) bottom mounted FNPT leak detection connection in secondary space (size per generator set manufacturer).
12. Internal baffles and outside wall stiffeners
13. Four (4) side mounted lift eyes with sufficient capacity to lift complete generator set
14. Top mounting holes for generator side base frame and vibration isolators, if applicable.
15. Bottom mounting holes for anchorage to concrete foundation.
16. Identification signage and labels in accordance with NFPA 704.
17. Identification nameplates for each tank connection.

The tank fill connection and normal vent connection shall be located outside the generator set enclosure to facilitate tank filling and vent pipe routing. All other connections shall be accessible from inside the generator set enclosure and positioned to permit easy access to the appurtenances mounted to the various tank connections.

F. As a minimum, the sub-base fuel storage tank shall be provided with the following appurtenances:

1. Fill connection drop tube terminating within 6" of bottom of tank.
2. Threaded fill cap, powder coated cast iron, vapor tight, padlockable, Model 178 as manufactured by Morrison Bros. Co., or equal.
3. Mechanical fuel gauge with graduated increments, visible from top of tank.
4. Low fuel level warning sensor and controller, fuel compatible wetted parts, adjustable, NEC Class I, Division 1 rated. Low fuel level warning sensor/controller shall be wired to the generator set control panel for local and remote warning indication.
5. Leak detection sensor and controller, fuel compatible wetted parts, NEC Class I, Division 1 rated. Leak detection sensor/controller shall be wired to the generator set control panel for local and remote alarm indication.
6. Emergency vent for primary space, opening pressure = 0.5 psig, full open pressure = 2.5 psig, Model 244 as manufactured by Morrison Bros. Co., or equal.
7. Emergency vent for secondary space, opening pressure = 0.5 psig, full
open pressure = 2.5 psig, Model 244 as manufactured by Morrison Bros. Co., or equal.

Threaded reducing bushings shall be provided as required to complete the connection of instruments to the tank openings. All unused tank openings shall be provided with threaded plugs.

Where specified in Part 1.02 herein, the fuel storage tank shall be provided with diesel fuel level monitoring system capable of continuously transmitting fuel level over a 2 wire system. The fuel level monitoring system shall be provided in accordance with Part 2.12 herein.

2.03 ENGINE COOLING SYSTEM

A. The cooling system shall consist of a unit-mounted radiator with blower type fan, integral jacket water circulating pump, and thermostatic control.

B. An engine driven fan behind the radiator will draw outside air through the enclosure intake air louvers, then through the radiator, and subsequent discharge out of the enclosure. Intake air louvers shall be provided in the size and quantity necessary to provide sufficient air flow for combustion and cooling of the engine and generator set.

C. A barrier between radiator and enclosure walls/roof shall be installed to prevent radiator air recirculation. Barrier shall be constructed of 14 gauge (minimum) galvanized sheet metal.

D. Engine radiator overflow tube and crank case fume disposal tube shall be vented to the exterior of the enclosure in front of the radiator.

E. Radiator drain shall be valved and routed through a short piping extension to the outside of the enclosure to facilitate proper draining.

F. The radiator shall be of sufficient capacity to operate the engine at full rated generator load at 120°F ambient temperature.

G. The engine cooling system shall be charged with a 30%-50% ethylene-glycol based antifreeze to provide corrosion and antifreeze protection.

H. Sensors shall be provided to detect low coolant level.
2.04 ENGINE EXHAUST SILENCING SYSTEM

A. Engine shall be provided with a properly sized critical grade (or better) exhaust silencer. The exhaust silencer shall be selected to meet the sound levels specified for the entire generator set assembly, including outdoor sound attenuated enclosure. As a minimum, the exhaust silencer shall be capable of a dynamic insertion loss of at least 30 dBA. The exhaust silencer shall be a separate unit, except where a combination exhaust silencer and DPF is specified. In general, the exhaust silencer shall be located in the generator set enclosure. Where a combination exhaust silencer and DPF is specified, the unit may be located outside the generator set enclosure; however, additional sound attenuation shall be provided, if necessary to achieve the sound levels specified for the entire generator set assembly (reference Subsection 2.08 herein). Exhaust silencers shall be as manufactured by Donaldson, Maxim, Miratech or equal.

B. Exhaust silencer shall be constructed of carbon steel and shall be equipped with flanged or plain end inlet and outlet, support brackets, and a drain plug to remove any condensation.

C. Exhaust silencer shall be provided with a stainless steel bellow expansion joint (flexible connector) installed between the engine and silencer. The exhaust silencer location and orientation shall be as required to accommodate additional exhaust system components (such as a DPF, if applicable) and achieve the specified generator set enclosure sound attenuation. The exhaust pipe outlet from the exhaust silencer shall be oriented vertically and shall be provided with a removable rain cap (sized the same diameter as the outlet).

D. Exhaust silencer, exhaust piping, and DPF (where specified) shall be sized to ensure that the exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer.

E. Exhaust silencer, exhaust piping, and DPF (where specified) shall be mounted so that their weight is not supported by the engine nor will exhaust system loads due to thermal expansion be imposed on the engine.

F. Exhaust silencer and associated carbon steel piping/components shall be provided with a high temperature rated protective coating, suitable for continuous service at the maximum engine exhaust temperature.

G. Exhaust silencer, exhaust piping, and DPF (where specified) shall be factory installed, including all supports and appurtenances.
2.05 ALTERNATOR

A. The alternator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling. Alternator shall be 3-phase, synchronous-type with a power factor of 0.8, frequency of 60 hertz, and voltage of 277/480. Alternator shall be 12 lead, extended range, readily able to be reconnected, and initially configured for 277/480 (unless noted otherwise). The insulation material shall meet NEMA standards for Class H insulation and be impregnated in a polyester varnish or vacuum impregnated with epoxy varnish to be fungus resistant. Temperature rise of the rotor and stator shall not exceed NEMA Class F (130°C rise by resistance over 40°C ambient at unit full load rating). The excitation system shall be of brushless construction.

B. The alternator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300 percent of rated current for 10 seconds during a fault condition.

D. The instantaneous voltage dip shall be within acceptable limits for each load step specified in Part 1.06, herein, and in no case shall the maximum instantaneous voltage dip exceed 20%.

2.06 VOLTAGE REGULATOR

An automatic voltage regulator (AVR) shall be provided to maintain alternator output voltage within +/- 1.0 percent for any constant load between no load and full load. The regulator shall be completely solid state design, and shall include electronic voltage buildup protection, volts per hertz regulation, over-excitation protection, loss of sensing protection, temperature compensation, limit voltage overshoot on startup, and be environmentally sealed for protection against vibration and atmospheric deterioration.

2.07 ENGINE-GENERATOR SET CONTROLS

A. Generator set shall be equipped with a control panel that provides complete
control and monitoring of the engine and alternator functions and performance. Control panel shall incorporate a microprocessor based controller with operator interface that provides local and remote system control, monitoring and protection. The controller shall be capable of PC based updating of all necessary parameters, firmware, and software. Manufacturer shall provide minimum two-year free subscription for computer software to interface with the control panel and engine electronic control module, including all software updates.

B. Critical control components shall be environmentally sealed to protect against failure from moisture and dirt. The panel shall be mounted on a separate support stand isolated from engine/alternator vibration. Panel/circuit breaker arrangements mounted on the generator set in such a way that restricts access to the AC generator terminal box are not acceptable.

C. The control panel shall provide full local annunciation of NFPA 110, Level 2 safety indications and shutdowns. The generator set and control panel shall be provided with all instrumentation and components necessary to control, monitor display, and transmit the engine and alternator functions and allow adjustments of listed adjustable parameters as specified herein. Control panel shall be provided with illuminating lights and backlight digital displays. Where specified, the control panel shall provide remote annunciation of safety indications and shutdowns in accordance with NFPA 110, Level 1.

D. As a minimum, the control panel shall monitor and display (digitally) the following:

1. Engine oil pressure
2. Coolant temperature
3. Engine rpm
4. Fuel level
5. System DC volts
6. Engine operating hours (non-resettable)
7. Generator AC volts (L-L and L-N)
8. Generator AC amps (per phase)
9. Generator frequency
10. Power factor
11. kW, kVA, kVAR, kW-hr

E. As a minimum, the control panel shall be provided with visual indication for the following alarm and status conditions:

1. Low oil pressure alarm
2. High coolant temperature alarm
3. Low coolant temperature alarm
4. Low coolant level alarm
5. Overspeed alarm
6. Failure to start (overcrank) alarm
7. Low battery voltage alarm
8. High battery voltage alarm
9. Low fuel level alarm
10. Fuel tank rupture alarm (fuel in tank annulus, interstitial space)
11. Battery charger fault
12. High coolant temperature warning
13. Low oil pressure warning
14. "Emergency Stop" pushbutton depressed
15. Control switch not in "Auto" position
16. Four (4) spare alarm/warning conditions, District assignable

Alarm conditions shall cause the generator set to shutdown.

F. Control Features and Interfaces. As a minimum, provide the following control features and interfaces:

1. Remote start/stop contacts.
2. Programmable auto cycle crank.
3. Programmable cool-down timer.
5. Audible alarm horn and silence pushbutton.
6. Alarm reset pushbutton.
7. Emergency Stop pushbutton (red mushroom-type) with auxiliary terminals for remote "Emergency Stop" indication.
9. "Generator Run" form "C" dry contact set rated 2A @ 30VDC (one N.O., one N.C.).
10. "Common Alarm" form "C" dry contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set (one N.O., one N.C.).
11. Dry contacts for remote start/stop, emergency stop, and M-O-A in auto position signals shall be 120VAC/30VDC rated and shall be wired to a terminal strip.
12. Where specified, control panel controller shall be equipped with a communication module capable of Modbus communication via an Ethernet 10/100 connection with RJ45 terminal jack.
G. All generator set wiring and terminations shall be properly identified by numbering or unique color coding. Such numbering and color coding shall correspond with identification on the wiring diagrams. Wiring shall land on terminal strips for connection, unless wiring is contained in a cable or harness with keyed plugs or connectors.

2.08 GENERATOR SET ENCLOSURE

A. General

Generator set, including: engine, cooling system, fuel system (except fuel tank), alternator, load bank (where specified), generator control panel, batteries, battery charger, and other auxiliary equipment required for a self-contained power generating system, shall be housed in a sound attenuated enclosure suitable for mounting on an outdoor concrete pad.

B. Outdoor Sound Attenuated Enclosure

1. Generator set outdoor sound attenuated enclosure shall be weatherproof and shall be constructed of panels fabricated from minimum 14 gauge steel. Dense, closed-cell foam acoustic insulation with reflective silver mylar outer layer shall be provided on enclosure inner surfaces. Roof panels shall be provided with mechanical retention pins for retaining the acoustic foam insulation. The combined generator set assembly, including engine, radiator fan, alternator, engine exhaust silencer (separate or combination silencer/DPF) and enclosure, shall attenuate sound levels to 75 dBA, or less, at a horizontal distance of 23 feet with the generator set running at full load.

2. Number of doors on enclosure shall be as required so that all normal maintenance operations, such as lube oil change, filter change, belt adjustment and replacement, hose replacements, control panel access, etc., may be accomplished without disassembly of any enclosure components. Access doors shall be fabricated of the same material as the enclosure walls and shall be reinforced for rigidity. Doors shall be equipped with rubber seals, stainless steel hinges, and flush fitting latches constructed of stainless steel or other corrosion resistant material. Door latches shall be key lockable, all doors shall be keyed alike. Door latch strike plates shall be stainless steel. All fasteners shall be stainless steel.
3. Enclosure air handling shall be designed and sized by the manufacturer to minimize static pressure drop through the enclosure and sound levels outside the enclosure.

4. Enclosure design shall be rodent-proof and tamper-proof, including conduit the stub-up area beneath the generator set unit.

5. Enclosure air intake and exhaust louvers and openings shall be equipped with bird screens.

6. Radiator access shall be through a hinged, lockable cover on the enclosure. Engine cooling fan and charging alternator shall be fully guarded to prevent injury.

7. Engine exhaust silencer shall be mounted inside the enclosure wherever feasible.

8. Where a DPF is specified, the unit shall be mounted on top of the enclosure, including units that combine the DPF and exhaust silencer.

9. Where a load bank is specified, the unit shall be mounted inside the enclosure directly on the engine radiator core wherever feasible. Units installed outside the enclosure shall be installed horizontally over the enclosure upward discharging radiator air hood.

10. Enclosure shall be provided with integral stiffeners or interior secondary support members as necessary to support generator set components, including, but not limited to: exhaust silencer, DPF (where specified), and load bank (where specified).

11. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color utilizing electrostatically applied powder polyester paint.

12. Lube oil and radiator drains shall be equipped with Type 316 stainless steel threaded ball valves, extension piping (to outside of enclosure) and threaded end caps.

13. Battery charger shall be mounted inside the enclosure.

14. One (1) interior LED light fixture with ON/OFF switch to illuminate the engine generator control panel. Lighting system shall obtain power via
15. Corrosion resistant battery tray and hold-down clamps.

16. NEMA 1 circuit breaker box with main line circuit breaker(s) per Part 2.09 herein mounted inside the enclosure and readily accessible via enclosure door.

17. The generator set wiring shall be securely attached to substantial supports along its entire route. The use of adhesive backed wire anchors is not acceptable. At no time shall the route come near or be a part of any heat source, exhaust system, or exhaust support. Where installed wiring is required to pass through any enclosure panel or partition, the wiring shall be protected with an insulating grommet at the point of passage. All electrical facilities and equipment shall be pre-wired inside the enclosure with connections for external wiring terminating in junction boxes located at the electrical conduit and conductor stub-up area.

2.09 GENERATOR SET AUXILIARY EQUIPMENT AND ACCESSORIES

A. Jacket Water Heater

Engine mounted, thermostatically controlled, UL listed, circulation type jacket water heater(s) shall be provided for each engine. Jacket water heater(s) shall be sized by the generator set manufacturer to maintain jacket water temperature at 90°F in an ambient temperature of 30°F. Jacket water heater(s) shall be provided with power cut-off relay(s). Jacket water heater(s) shall operate on 120 or 240 volt, single phase, 60 hertz power, as indicated on the Drawings. Provide a separate receptacle for connection of the jacket water heater to the power supply circuit. Provide proper power supply circuits for the heater(s) as required for the voltage and load of the heater(s), connected to a lighting panel circuit as shown on the Drawings. Generator set supplier shall coordinate lighting panel circuit breaker voltage and amperage rating with Contractor to ensure that the proper circuit breaker is provided for the jacket water heater(s).

B. Space Heater

Where specified, provide an alternator mounted space heater. Space heater shall operate on 120 VAC, single phase electrical power.
C. Starting and Control Batteries

1. A lead-acid battery set of the heavy-duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. The battery set shall be capable of delivering the manufacturer's recommended minimum cold-cranking amps required at 0°F (per SAE Standard J-537). All necessary battery cables and clamps shall be provided.

2. Battery system shall be equipped with a lockout/blockout disconnect switch. Disconnect switch shall be rated for 500 A continuous current and 2,500 A peak current, and shall be capable of padlocking in the "OFF" position.

3. Battery tray(s) shall be provided for the batteries and shall conform to NEC 480-8. Battery tray(s) shall be constructed of non-metallic material. Construction shall be such that any battery spillage shall be contained within the tray to prevent a direct path to ground.

D. Battery Charger

Provide a 120 VAC, enclosed, automatic equalizing, dual-rate, selectable for lead-acid or activated glass mat (AGM) batteries, solid-state, constant voltage type battery charger with automatic AC line compensation. Battery charger shall be provided with a NEMA 1 enclosure with vibration isolators. DC output shall be voltage regulated and current limited. Charger shall have two ranges, float and equalize, and shall provide continuous taper charging. The charger shall have a continuous output rating of not less than 10A, and shall be sized to recharge the engine batteries in a minimum of 4 hours while providing the control power needs of the engine. The battery charger shall comply with UL 1564, and shall be provided with the following features and capabilities:

1. DC rated output matching batteries
2. DC ammeter
3. DC voltmeter
4. Equalize light
5. AC power on light
6. Low voltage light
7. High voltage light
8. Equalize test button/switch
9. AC circuit breaker
10. Low DC voltage alarm relay
11. High DC voltage alarm relay
12. Current failure relay
13. AC power failure relay.
14. Fused DC output.

Charger shall be Samlex Model SEC, 3 stage, fully automatic battery charger, or equal.

E. Electrical Connection Box

Generator set electrical components shall be factory installed, including wiring. All electrical components requiring connection to District's remote wiring, such as power for jacket water heater, alternator space heater and battery charger, and signals to/from the generator set control panel, DPF control panel (if applicable), and load bank control panel (if applicable) shall be pre-wired to an electrical connection box(es). The electrical connection box(es) shall be located inside the generator set enclosure near the conduit stub-up area.

F. Generator Set Circuit Breakers

1. Provide a generator set mounted main circuit breaker equipped with a DC shunt trip. The circuit breaker shunt trip device shall be connected to engine/generator safety shutdowns and shall open the circuit breaker on a shutdown condition.

2. Where a load bank system is specified, provide a generator set mounted load bank circuit breaker.

3. Unless indicated otherwise on the Drawings, circuit breakers shall be molded-case thermal-magnetic type or electronic trip type, 480 volt, 3 pole, 60 hz, UL listed, and conforming to NEMA AB1 and UL489. Circuit breakers shall be mounted and wired in separate NEMA 1 steel enclosures with dead front panels. Circuit breakers shall be lockable in the "OFF" position. Circuit breaker enclosures shall be arranged to accept conduit connections stubbed-up through the concrete foundation and sub-base fuel storage tank. Provide sufficient wire bending space and terminals for connection of conductor compression type connectors. The main circuit breaker enclosure shall be equipped with one ground bus bar and one isolated neutral bus bar. Bus bars shall be tin-plated copper, rigidly mounted, and provided with terminals suitable for termination of manufacturer ground and neutral conductors, and generator output feed conductors (size and quantity as indicated on the Drawings).
4. Unless indicated otherwise on the Drawings, circuit breakers shall utilize an 80% rated thermal-magnetic trip units. Manufacturer’s selection of the circuit breaker type and associated trip curve shall be coordinated with the alternator thermal damage curve to ensure that the circuit breakers protect the alternator from damage due to a line-to-line short, or line-to-ground short. Circuit breaker current continuous current ratings shall be selected for the maximum full load capabilities of the generator set and load bank (where specified). Circuit breaker short-circuit current rating shall be as determined by the Contractor’s short-circuit and protective device evaluation and coordination studies performed in accordance with Specification Section 16040. As a minimum, circuit breakers rated 250 A and less shall have a short-circuit current rating of at least 18,000 A at 480 VAC, and circuit breakers rated over 250 A shall have a short-circuit current rating of at least 35,000 A at 480 VAC.

5. Generator/exciter field circuit breakers will not be acceptable for overcurrent protection.

G. Grounding and Bonding

1. Provide a factory installed, code sized grounding conductor from the alternator ground pads to the engine generator frame and to a grounding lug in the generator set main circuit breaker enclosure. Grounding lug shall be sized to accept the grounding electrode conductor(s) and grounding conductor(s) in the generator feed conduit(s), as indicated on the Drawings.

2. Provide a factory installed, code sized neutral conductor from the alternator neutral to a neutral block in the generator set main circuit breaker enclosure. Provide a neutral block capable of connecting a minimum of two customer neutral conductors of the same size as the generator set neutral conductor.

3. Provide factory installed bonding and grounding conductors from all electrical equipment, components, devices, instruments, panels, and boxes to engine generator frame ground.

4. Provide factory installed bonding and grounding conductors for any electrically isolated section of metallic piping or equipment.
Vibration Isolation and Anchorage

1. Provide vibration isolators with type, location, and quantity as determined by the generator set manufacturer. Vibration isolators shall be provided between the alternator/engine and base frame, or between the base frame and sub-base fuel tank. Vibration isolators shall be elastomeric pad type or spring type.

2. Elastomeric isolator pads shall be oil and water resistant elastomer or rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over the pad area, and factory cut to sizes that match the requirements of the supported equipment.

3. Spring isolators shall be freestanding, steel, open-spring isolators with seismic restraint.
   a. Housing: steel with resilient vertical limit stops to prevent spring extension due to seismic loads or if weight is removed; factory drilled baseplate bonded to elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt.
   b. Outside Spring Diameter: not less than 80% of compressed spring height at rated load.
   c. Minimum Additional Travel: 50% of required deflection at rated load.
   d. Lateral Stiffness: more than 80% of rated vertical stiffness.
   e. Lateral Restraint Rating: more than 110% of calculated maximum seismic force per isolator.
   f. Overload Capacity: support 200% of rated load, fully compressed, without permanent deformation or failure.
   g. Minimum Deflection: 1 inch.

4. Vibration isolators shall be as manufactured by Cal Dyn, or equal.

5. Generator set sub-base fuel tank shall be rigidly anchored to a reinforced concrete foundation. Anchor bolts shall be Type 316 stainless steel and shall be cast-in-place or drilled and epoxied (wedge anchors are not acceptable). Generator set manufacturer shall determine the required size, location, and embedment depth of anchor bolts. Anchor bolt embedment depth shall be limited to the overall thickness of the reinforced concrete foundation minus 3 inches.
I. Engine Exhaust System Piping, Components, and Insulation

1. Engine exhaust piping shall be constructed of carbon steel or stainless steel pipe. Piping thickness and connection type shall be per manufacturer's recommendations.

2. A bellows expansion joint shall be provided at the engine exhaust connection. Bellows expansion joint shall be constructed of Type 321 stainless steel.

J. Engine Fuel System Piping and Components

1. Unless indicated otherwise on the Drawings, engine fuel system piping shall be carbon steel ASTM A53 or A106, Grade B, Schedule 40, seamless pipe. Connections shall be threaded, welded, or flanged. Threaded fittings shall be ASTM A197, ANSI B16.3, Class 150 minimum. Welded or flanged fittings shall be ASTM A234, ANSI B16.9, Standard Weight, smooth-flow (mitered fittings are not acceptable).

2. Engine supply and return fuel line connections to the engine shall be made with flexible fuel hose to facilitate component movement during operation. Flexible hose shall be factory installed, rated for diesel service, and provided with braided stainless steel wrapping. Flexible fuel hose shall be rated for a minimum of 100 psi and 300°F.

3. Vent piping shall be provided for the sub-base fuel storage tank normal vent. Vent piping shall be factory installed and shall extend a minimum of 12' above the bottom of the fuel tank. Where feasible, vent piping shall be routed outside the generator set enclosure, adjacent to the enclosure end, and shall be provided with lateral support near the top of the enclosure. Where vent piping is routed inside the generator set enclosure, watertight flashing shall be provided around the roof penetration. Vent piping routing shall not interfere with access to any generator set equipment or components.

4. The top of the vent piping shall be equipped with an updraft vent cover designed to direct fuel vapors outward and upward in accordance with NFPA 30 requirements. Vent cover body and cap shall be die cast aluminum, and provided with a 40 mesh stainless steel debris and insect screen. Vent cover shall be Model 354T, as manufactured by Morrison Bros. Co., or equal.
2.10 **DIESEL PARTICULATE FILTER (DPF) SYSTEM (NOT REQUIRED)**

Where specified, the generator set shall be furnished with a DPF system to reduce the diesel particulate matter (PM) in accordance with SCAQMD Rule 1470. The DPF system shall meet the following requirements:

A. The DPF system shall utilize a low temperature passive DPF.

B. The DPF shall be as manufactured by Johnson Matthey, Miratech, or equal.

C. The DPF shall meet California Air Resources Board (CARB) Level 3 requirements at a minimum, and shall be verified for the specific engine make/model that it will be installed on and with a PM reduction greater than 85%.

D. The CARB Executive Order for the DPF shall either list compatibility to the generator engine family name or approval shall be granted by SCAQMD.

E. The proposed engine shall be a certified CI engine that meets the following standards:

1. PM emission standards specified in SCAQMD Rule 1470 Part (c)(2)(C)(iv).

2. Emission standards specified in SCAQMD Rule 1470 Part (c)(2)(C)(vii) for other pollutants.

F. Total exhaust system backpressure shall not exceed 90% of engine manufacturer's maximum allowable backpressure and shall be coordinated with other exhaust system components (e.g. piping, fittings, rain cap, etc.). Generator set supplier shall confirm exhaust size shown on the Drawings is sufficient to ensure the total exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer.

G. The DPF system shall be equipped with continuous exhaust backpressure monitoring and shall provide notification when high backpressure limit is reached. A normally open dry contact that closes if the backpressure limit is reached shall be provided for District's use.

H. The DPF unit shall be provided with an integral exhaust silencer. As a minimum, the integral DPF/silencer unit shall be capable of a dynamic insertion loss of at least 30 dBA.
I. The DPF unit housing shall be suitable for horizontal installation and shall be provided with flanged inlet and outlet nozzles at each end of the housing. The DPF housing and flanges shall be constructed of Type 304 stainless steel. The DPF housing shall be provided with Type 304 stainless steel support brackets.

J. Each DPF system shall be provided with a DPF emissions monitoring controller. The emissions monitoring controller shall be factory mounted on the generator set. The emissions monitoring controller shall be suitable for operating on 10-30 VDC power and shall accept instrumentation wiring from inlet and outlet thermocouples, inlet exhaust pressure sensing line, and engine run status signal from the generator set control panel. The emissions monitoring controller shall be provided with LED visual indicating lights and customer dry contact alarm outputs/inputs for high exhaust backpressure, low exhaust temperature, and engine run signals.

K. The DPF system shall be provided with thermocouples for monitoring exhaust inlet and outlet temperatures. Thermocouples shall meet the following requirements:

1. Each thermocouple probe shall be Type K, with a 1/4" diameter sheath constructed of Inconel. Probe mounting threads shall be 1/2" diameter NPT. Probe length shall be as determined by the generator set supplier for the exhaust piping size and threaded outlet for thermocouple. Contractor shall coordinate size and location of exhaust piping threaded outlets for thermocouples with generator set supplier.

2. Thermocouple probes shall be provided with industrial protection heads suitable for outdoor installation. Protection head shall be constructed of cast iron, hot dipped galvanized. Protection head shall be provided with 1/2" FNPT openings for probe connection tube entry and extension cable entry. An internal terminal block shall be provided for termination of cable wiring.

3. Thermocouple probes and protection heads shall be Model NB1-CAIN-14, as manufactured by Omega, or approved equal.

L. The DPF manufacturer shall provide all necessary equipment and appurtenances required for a complete and operable system, including, but not limited to: DPF/silencer, emissions monitoring controller, inlet/outlet thermocouples, backpressure piping and tubing, backpressure transducer, pressure gauge, and moisture separator.
2.11 LOAD BANK SYSTEM

A. Unless specified otherwise, generator sets furnished with a passive DPF shall also be equipped with a load bank system. The load bank system shall operate with the generator set to maintain sufficient load on the generator and create adequate engine exhaust temperature for proper operation of the DPF and compliance with SCAQMD emissions requirements.

B. Where specifically indicated on the Drawings and/or specified herein, generator sets shall be provided with a load bank system, even if a passive DPF is not required. Where a passive DPF system is not required but a load bank system is specified, the load bank system shall meet all requirements specified herein.

C. The load bank system shall consist of a resistive load bank, load bank control panel, and appurtenances. The load bank system manufacturer shall coordinate with the generator set manufacturer to ensure that all necessary equipment and components are provided, and that said equipment and components comply with these Specifications.

D. The load bank and associated control panel shall be designed in accordance with the latest applicable NEMA, NEC, and ANSI standards. The load bank and control panel shall be UL 508A listed and labeled. The load bank and control panel shall be as manufactured by ASCO (Avtron Loadbank), Simplex Inc., or equal.

E. The load bank shall be designed as a supplemental load to the generator set, and shall be sized at 50-60% of generator nameplate kW rating (not 100%). The load step resolution provided by the load bank system shall be a nominal 20% to 25% of the load bank rating. The load bank shall be designed and fabricated for continuous duty cycle operation, with no limitations.

F. The load bank shall be air cooled via air from the engine radiator fan. Load bank sizing shall be coordinated with available air flow engine radiator fan and associated heat rejection when operating under maximum ambient temperature conditions. The load bank shall be radiator-mounted wherever feasible, and suitable for installation directly on the engine radiator core. Where generator set enclosure constraints do not allow for the load bank to be radiator-mounted, the load bank shall be installed horizontally over the enclosure upward discharging radiator air hood.

G. The static pressure drop across the load bank shall not exceed 0.10" of water column with generator set operating at full rated load. The main input load bus, load step relays, fuses, and control relays shall be located within the load bank
enclosure. The load bank shall be designed for installation and operation outdoors. The load bank enclosure shall be rated NEMA 3R, or better. All exterior fasteners shall be stainless steel.

H. Load elements shall be helically or spirally wound chromium alloy rated to operate at approximately 1/2 of maximum continuous wire rating. Elements shall be fully supported across their entire length within the air stream using segmented ceramic insulators on stainless steel rods. Element supports shall be designed to prevent a short-circuit to adjacent elements or to ground.

The change in resistance due to temperature shall be minimized by maintaining conservative watt densities.

The overall tolerance of the load bank shall be +5% to 0% kW at rated voltage. A +5% to -5% rating that allows the load bank to deliver less than rated kW will not be acceptable. The load bank shall deliver full rated kW at rated voltage.

I. Protective devices shall include an over-temperature switch to sense the load bank exhaust air. The switch shall be electrically interlocked with the load application controls to prevent load from being applied in the event of an over-temperature condition. The load bank shall be provided with a separate main circuit breaker. In addition, branch fuses shall be provided on all three phases of switched load steps above 50 kW. Branch fuses shall be current limiting type with an interrupting rating of 200 KAIC at 480V.

The exterior of the load bank shall be provided with the appropriate warning/caution labels on all access panels.

J. Load Bank Control Panel

The load bank system shall be provided with a local control panel. As a minimum, the control panel shall be provided with the following features, functions, and capabilities:

1. Control features:
   a. Power ON/OFF switch
   b. Master load ON/OFF switch
   c. Load step switches for ON/OFF application of individual load steps
2. Visual indicators:
   a. Power ON indication light
   b. OVER-TEMPERATURE light

3. A remote activated "load dump" circuit shall be provided as part of the load bank control circuitry. Provisions shall be provided to remove the load bank offline from the operation of a remote normally closed set of auxiliary contacts from an automatic transfer switch or other device. In the event of the remote contact opening, all load shall be removed.

4. The control panel enclosure shall be rated NEMA 1 where mounted inside the generator set enclosure, and rated NEMA 4 where mounted to the outside of the generator set enclosure. Panel enclosures mounted outside the generator set enclosure shall be provided with hinged doors and padlockable door hasps.

5. An automatic load step controller shall be provided for maintaining a minimum load on the generator set. The controller shall monitor the connected downstream loads and shall automatically add or subtract load steps in response to facility load changes as to maintain a minimum load level on the generator set. The controller shall include an initial time-delay circuit, and automatic time delayed load step application circuit. A remote contact closure shall be provided for activation and transfer of control. A separate current transformer shall be provided for sensing of downstream loads.

6. When generator set is operating during a power outage, facility loads (motors, transformers, etc.) will change depending upon operation. Where indicated on the Drawings, when an equipment unit is called to start, the District RTU will send a contact closure to the load bank controller to drop load bank resistance such that the equipment unit shall start when the generator has no load from the load bank. Once the equipment unit is running, the District RTU will open the contact closure and the load bank controller shall add resistive load as necessary to provide the minimum load on the generator.

7. Upon restoration of normal power, the automatic transfer switch shall transition from emergency power to normal power. The generator set shall then commence a cool-down cycle. Where indicated on the Drawings, the District RTU will send closed contact signal to the resistive load bank controller to drop load during the generator set cool-down cycle.
8. An integral control power transformer shall be provided to supply 120 volt, 1 phase, 60 hertz to the load bank's control and safety circuitry. Transformer primary and secondary control circuits shall be fuse protected.

2.12 DIESEL FUEL LEVEL MONITORING SYSTEM

Where specified, the generator set shall be provided with a continuous diesel fuel level monitoring system. The fuel level monitoring system shall meet the following requirements:

A. Ultrasonic liquid level measurement system shall consist of an electronic transducer device to provide continuous diesel fuel level monitoring within the sub-base fuel storage tank.

B. The device shall be capable of continuously transmitting liquid level data over a two wire (4-20 mA isolated output signal) system. The device shall be capable of being calibrated without removing the transducer. The transmitter housing shall be constructed of fire resistant ABS plastic and shall be rated NEMA 6P. Ultrasonic liquid level measurement system shall be suitable for installation with low sulfur diesel fuel.

C. The device shall be capable of accurately measuring the level of clean or dirty liquids (0.2% of measuring range). The device beam width shall be 2" in diameter. The transducer material shall be constructed of PVDF and shall be provided with FKM gasket. Level transducer shall be capable of measuring the entire level range in the storage tank.

D. The transducer assembly shall be provided with a minimum 1" NPT connection suitable for installation in a female threaded coupling, and rated for a working pressure of 30 psi (minimum) at a temperature of 140 degrees F.

E. Manufacturer shall provide written confirmation that the material selection for all transducer wetted components and electrical control system is suitable for use with low sulfur diesel fuel.

F. Ultrasonic liquid level measurement system shall be Omega, or equal.

G. Level monitoring device shall be factory installed in the sub-base fuel tank and tested prior to shipment. Level monitoring device signal cables shall be connected to the generator set control panel. Generator set control panel shall
be configured to provide the continuous level measurement via 4-20 mA output for District use.

2.13 PAINTING AND PROTECTIVE COATINGS

A. Generator set enclosure, engine, alternator, control panel, and components shall be coated using the standard surface preparation and paint normally supplied by the manufacturer for this application.

B. Carbon steel fuel piping, including vent piping, shall receive two coats of epoxy (primer plus finish coat), or manufacturer’s equivalent.

2.14 SPARE PARTS

A. For each generator set, Contractor shall furnish the spare parts normally provided with said equipment plus the following:

1. Two (2) complete sets of filters for fuel, oil, and air systems.

2. Two fuses of each rating.

3. Supply of lubricants for first lubricant change.

4. All additional lubricants and fuel required while generator is in operation during factory testing, and field startup, testing and initial operation.

B. Spare parts shall be packed in suitable containers or boxes bearing labels clearly designating the contents and the piece of equipment for which they are intended. Spare parts shall be delivered to the District at the same time of equipment field startup and testing.

PART 3 - EXECUTION

3.01 GENERAL

A. Generator set shall be fully assembled, pre-wired, and ready for delivery, prior to commencing factory performance testing as specified herein.

B. The Contractor shall arrange to have the manufacturer or supplier of the equipment furnished under this Section provide the services of competent factory-trained personnel to supervise generator set installation and startup and
field testing activities.

3.02 DELIVERY AND HANDLING

A. Deliver equipment properly packaged and mounted to facilitate handling.

B. Deliver equipment with recommended lube oil and coolant installed.

C. Handle equipment carefully to prevent physical damage. Lift equipment using manufacturer supplied attached points and in accordance with manufacturer's printed instructions.

D. Do not install damaged equipment; remove any damaged equipment from the site and replace with new equipment.

3.03 INSTALLATION

A. Coordinate routing of all facility conduit related to generator set with manufacturer and ensure all conduit stub-ups are located properly for bottom entry into generator set conduit stub-up area and aligned with associated terminal connections per manufacturer's equipment shop drawings.

B. Install equipment in strict accordance with manufacturer's written installation, application, and alignment instructions.

C. Install equipment and material in accordance with the applicable portions of NFPA 30 and 110.

D. Anchor generator set to concrete foundation with Type 316 stainless steel anchor bolts (cast-in-place or drilled and epoxied). Anchor bolt type, number, diameter and embedment shall be per the manufacturer's anchorage calculations. Unless specified otherwise, install a continuous and level layer of 1/2” +/- thick high strength non-shrink grout beneath all sub-base fuel storage tank bearing surfaces.

E. Furnish and install all interconnecting conductors and cables between generator set and facility electrical equipment.

F. Furnish and install equipment grounding connections and materials for the generator set in accordance with NFPA 70 for a separately derived system.

G. Adjust short circuit protective devices in accordance with the manufacturer's
recommendations and Contractor's short circuit and protective device coordination studies.

3.04 PERFORMANCE TESTS

A. Manufacturer/Supplier Testing

Each completed generator set shall be factory tested. Testing shall be performed at the manufacturer's or supplier's regular place of business and shall be conducted on a "resistive load bank". Testing may be witnessed by the District’s representative. Manufacturer/supplier shall provide written notice to the District a minimum of two (2) weeks prior to testing. Three (3) certified copies of the test results shall be forwarded to the District within five (5) days following the testing. Test results shall be reviewed and approved by the District prior to shipping the generator set to the project site. As a minimum, manufacturer/supplier testing shall consist of the following:

1. Perform engine manufacturer's recommended pre-starting checks.

2. Start engine and make engine manufacturer's after-starting checks during a reasonable run-in or warm-up period.

3. Run generator set continuously as follows:
   a. Operate the generator set for one (1) hour at 1/2 full rated load.
   b. Follow above run immediately with one (1) hour at 3/4 full rated load.
   c. Follow above run immediately with two (2) hours at full rated load.
   d. If safe operating limits as specified hereunder and recommended by the generator set manufacturer are exceeded during the preceding test, the necessary changes and adjustments shall be made and the complete test shall be repeated.

4. Instrumentation: The following generator set parameters shall be read and recorded at 15-minute intervals throughout the test:
   a. Engine Oil Pressure
b. Jacket Water Temperature

c. Engine RPM

d. Ambient Air Temperature

e. Generator Voltage

f. Generator Amperage

g. Generator Frequency

h. Power Factor

i. Kilowatts (kW)

Note: All engine instrumentation readings must remain static one (1) hour prior to end of test period.

5. The following engine control tests shall be made:

a. Demonstrate functioning of high temperature coolant circuit safety device.

b. Demonstrate overspeed shutdown device.

c. Demonstrate operation of low oil pressure safety device.

B. Startup and Field Testing

Prior to final acceptance, Contractor shall startup and field test each generator set. Contractor, a representative of the generator set supplier, and the District will be present. Contractor shall be responsible for the proper conduct of the tests and to furnish equipment and labor required to make the tests. Contractor shall provide all materials, supplies, and instruments required for the tests, including, but not limited to, fuel and all metering equipment. Contractor shall leave the fuel tank full at the conclusion of all field testing. As a minimum, startup and field testing shall include the following:

1. Verify that all equipment, components, and auxiliary devices are properly installed, lubricated, adjusted, and ready for operation.
2. Check and record all fluid levels.

3. Test and record insulation resistance of all power buses, components, feeders, and branch circuit conductors.

4. Verify that all equipment and material is properly bonded and grounded. Verify tightness of all power and control conductor terminations.

5. Check all auxiliary devices for proper operation, including battery charger, jacket water heater(s), alternator space heater, fuel storage tank level and leak detection sensors and controllers, and generator set control panel (including local and remote annunciation), and load bank instrumentation and control panel (where specified).

6. Test and record all alarms and safety shutdown devices for proper operation and annunciation. Test alarms and safety shutdowns to the fullest extent possible. Simulate alarm conditions where necessary to avoid equipment damage.

7. Start engine and check for exhaust leaks, fuel leaks, oil leaks, excessive vibration, etc.

8. Verify and record voltage output and phase rotation at the transfer switch, prior to connecting the transfer switch to the load.

9. Generator set shall be tested by actual starting of the facility equipment specified herein, and their continuous operation for a one (1) hour period. During that period, Contractor shall observe and record the following data at 15-minute intervals: engine oil pressure, engine jacket water temperature, engine RPM, generator voltage per phase, amperage per phase, frequency, power factor, and kW.

10. Where a DPF system is specified, proper system operation shall be verified, including associated instrumentation, controller, and local/remote annunciation of all alarm and status signals. DPF operating parameters shall be monitored and recorded for a one (1) hour period (total period). During the first 30-minutes of that period, the DPF system shall be tested by operation with the load bank system only, followed by 30-minutes of operation with the actual facility equipment and load bank system, if necessary. Load bank system shall be automatically operated with actual facility loads, if necessary to maintain engine exhaust temperature to the DPF. During the field testing period, Contactor shall
measure and record the following data at 15-minute intervals: engine exhaust backpressure, engine exhaust temperature at DPF.

11. Where a load bank system is specified, proper system operation shall be verified, including associated instrumentation, control panel and local/remote annunciation of all alarm and status signals. Load bank system operating parameters shall be monitored and recorded for a one (1) hour period (total time). During the first 30-minutes of that period, the generator set shall be operated with the load bank system only with a minimum of 10-minutes at each load bank step, followed by 30-minutes of operation with the actual facility equipment and load bank system. Load bank system shall be automatically operated with actual facility loads and load bank steps shall be added or subtracted to maintain a minimum load level on the generator set. During the field testing period, Contactor shall measure and record the following data at 15-minute intervals: load bank temperature, generator voltage per phase, amperage per phase, frequency, power factor, and kW.

12. If the equipment or generator set and accessories do not operate in a satisfactory manner, the trouble shall be located and promptly repaired by the Contractor.

13. Contractor shall assemble all recorded field data and submit same to District for review and approval. An analysis of the actual field test will determine the acceptability of the unit. If the unit does not perform in conformity with these Specifications and/or the certified test data, the Contractor will be required to remove, replace, and restore the equipment to full compliance with these Specifications at his expense.

3.05 MANUFACTURER’S CERTIFICATION

A. A qualified factory-trained manufacturer’s representative shall certify in writing that the generator set has been installed, adjusted, and tested in accordance with the manufacturer’s recommendations. Equipment shall be inspected prior to the performance of field testing and the preparation of any reports.

B. Manufacturer's written certification shall be provided in accordance with Sections 01810 and 11005.

3.06 CLEANUP

A. All parts of the equipment and materials shall be left in a clean condition.
Exposed parts shall be clean of dust, dirt, diesel, oil, grease, and other materials and debris. All, fuel, oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and cleaned.

B. Paint touch-up matching factory color and finish shall be applied to all scratches on equipment, components, panels and enclosures.

### 3.07 INSTRUCTION

A. After the generator set has been installed, tested, and adjusted, and placed in satisfactory operating condition, the equipment manufacturer shall provide classroom instruction to District’s personnel in the use and maintenance of the equipment. Manuals and handouts shall be provided to each participant. Instruction shall address function and operation of engine-alternator, major sub-systems, and components. Instruction shall be provided on the generator set control panel, DPF control panel (where specified), and load bank control panel (where specified), including operator interfaces, menu navigation, changing control parameters, and modifying setpoints. Instruction shall also include routine maintenance, troubleshooting, adjustments, and repairs.

B. Four (4) hours of instruction shall be provided unless otherwise specified. Contractor shall give the District formal written notice of the proposed instruction period at least two (2) weeks prior to commencement of the instruction period. Scheduled training shall be at a time acceptable to the District and the manufacturer. During this instruction period, the manufacturer shall answer any questions from District personnel. The manufacturer's obligation shall be considered ended when he and the District agree that no further instruction is needed. Cost for this instruction shall be included in the price bid.

END OF SECTION
SECTION 13025
PREFABRICATED SEWAGE LIFT STATION

PART 1 – GENERAL

1.01 GENERAL

A. Contractor shall provide a pre-engineered, prefabricated fiberglass sewage lift station as shown on the Drawings and as specified herein. The prefabricated sewage lift station (PLS) shall include: fiberglass wet well, submersible pumping units, internal piping, pump control panel, fiberglass valve vault, internal piping, valves, aluminum access hatches, accessories, and auxiliary equipment. The prefabricated sewage lift station shall be manufactured and supplied by Flygt, no substitutes.

B. Contractor shall procure, deliver, unload, install, connect, test, and place into operation a prefabricated sewage lift station as shown on the Drawings and as specified herein.

C. Contractor shall provide all materials, equipment, and labor necessary to provide a complete and operable sewage lift station as shown on the Drawings and as specified herein. Contractor shall note, that all materials and equipment necessary for a complete and operable lift station are not specified in this Section. Contractor shall coordinate with the prefabricated lift station supplier (PLSS) to ensure that all materials, equipment, and appurtenances required for a complete and operable sewage lift station are included in the Contractor's project bid price.

D. Where inter-system components, devices, piping, adapters, etc. are specified or noted on the Drawings, but required for a complete system, it shall be the responsibility of the Contractor to provide such items and material as a part of the Work.

1.02 SPECIFIC SEWAGE LIFT STATION REQUIREMENTS

A. Provide one (1) 6'-0" inside diameter by 24'-0" deep wet well and one (1) 6'-0" inside diameter by 5'-6" deep valve vault as shown on the Drawings and as specified herein.

B. Provide two (2) submersible pumping units as shown on the Drawings and as specified in Specification Section 11073.
C. Provide one (1) duplex pump control panel (PCP) as shown on the Drawings and as specified herein. Pump control panel wiring shall be as shown on schematic diagrams in Appendix E of these Specifications.

D. The below grade wet well and valve vault structures shall be designed for the following site specific soil parameters:

1. Average compacted fill moist unit weight (pcf) 125
2. Angle of internal friction of soils (degrees) 33
3. Soil cohesion, c (psf) 0
4. Lateral earth pressure, at-rest (pcf) 100 (saturated)
5. Depth from ground surface to groundwater (ft) 0
6. Allowable foundation bearing pressure (psf) 4,500

E. The wet well and valve vault structures shall be designed for buoyant forces created by groundwater up to the ground surface. For the purpose determining the maximum buoyant force acting on the wet well, the wet well shall be considered empty.

1.03 RELATED SECTIONS

A. The Contract Documents are a single integrated document, and as such all Specification Sections apply. It is the responsibility of the Contractor and its subcontractors to review all Sections and ensure a complete and coordinated project.

B. Related Specification Sections include, but are not limited to, the following:

1. Division 11 – Equipment
2. Division 13 – Special Construction
3. Division 15 – Mechanical
4. Division 16 – Electrical
5. Division 17 – Instrumentation and Controls
1.04 Reference Standards, Specifications, and Codes

A. Equipment and materials shall meet or exceed the applicable requirements of the following standards, specifications, and codes (latest edition):

Institute of Electrical and Electronics Engineers (IEEE)

IEEE 519 Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

IEEE C62.41.1 Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits

IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

National Electrical Manufacturers Association (NEMA)

NEMA 250 Enclosures for Electrical Equipment (1000 V Maximum)

NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches

NEMA ICS 1 Standard for Industrial Control and Systems: General Requirements

NEMA ICS 4 Terminal Blocks

NEMA ICS 5 Industrial Control Systems, Control Circuit and Pilot Devices

NEMA ICS 6 Enclosures

National Fire Protection Association (NFPA)

NFPA 70 National Electrical Code

Underwriters Laboratories (UL)

UL 50 Standard for Enclosures for Electrical Equipment, Non-environmental Considerations

UL 50E Standard for Enclosures for Electrical Equipment, Environmental Considerations
UL 489 Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

UL 508A Standard for Industrial Control Equipment

UL 698A Standard for Industrial Control Panels Related to Hazardous Locations

UL 913 Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1 Hazardous (Classified) Locations

B. Equipment shall bear the appropriate labels and markings in accordance with above standards, specifications and codes. Equipment shall be designed, manufactured, and tested in certified International Organization for Standardization (ISO) 9001 facilities.

1.05 CONTRACTOR SUBMITTALS

A. All submittals shall be in accordance with the District's General Conditions, Section F – Labor and Construction, "Submittals".

B. Shop Drawings/Submittals

Contractor shall prepare and submit shop drawings/submittals for all lift station equipment and materials to be furnished by the PLSS for review and acceptance by District prior to fabrication and delivery.

Shop drawings/submittals shall show the dimensions, ratings, materials of construction and other relevant details of the prefabricated lift station (PLS) equipment and material to be furnished. Manufacturer product literature and specifications shall be marked to clearly identify all applicable information and crossing out inapplicable information. Applicable sizes, model numbers, and options shall be clearly marked. Sufficient data and details shall be provided to demonstrate compliance with these Specifications and the Construction Drawings.

As a minimum, shop drawings/submittals shall include the following information:

1. Manufacturer catalog cut sheets and specification sheets for all PLS equipment and components indicating sizes, ratings, performance
characteristics, materials of construction, standard features, options, accessories, etc.

2. Weights of all equipment.

3. Dimensional drawings for PLS equipment and material items including locations and requirements for all external connections and mountings/supports.

4. Detailed drawings showing all fabricated access hatch dimensions and clear openings.

5. Where Drawings show equipment hatches located over fixed position equipment, such as pumping units and valves, Contractor shall provide additional shop drawings showing the hatch and equipment to be accessed superimposed. Drawings shall show hatch and equipment dimensions along with clearances between the hatch and equipment, on all 4 sides of the hatch. Clearances shall be based on a true vertical lift of the equipment through the hatch. Contractor shall adjust the position and/or clear opening dimensions of the hatch as necessary to accommodate removal/installation of the proposed equipment through the hatch.

6. Complete information, drawings, and technical data for the proposed pumping units. Pumping unit submittal information, drawings, and technical data shall be in accordance with the requirements specified in Section 11073.

7. Complete information, drawings, schematics, diagrams, and technical data for the proposed pump control panel, including all equipment, material, and components. Pump control panel submittal information, drawings, schematics, diagrams, and technical data shall be in accordance with the requirements specified in Section 16950.

8. Complete information, drawings, schematics, diagrams, and technical data for all instrumentation and control components. Instrumentation and control component submittal information, drawings, schematics, diagrams, and technical data shall be in accordance with the requirements specified in Section 17006. In addition, interconnection diagrams and loop drawings shall be provided as specified in Section 17006.
9. Installation instructions including unloading, handling, and placement procedures for wet well and valve vault, and mounting and connection procedures for all mechanical and electrical equipment.

B. Operation and Maintenance Manual

Contractor shall prepare and submit a complete and organized operation and maintenance (O&M) manual for all equipment and components. The O&M manual shall include, but not be limited to, the following:

1. Performance Data and Drawings
   a. Detailed Bill of Materials for all equipment, materials, and components, listing: quantity, manufacturer's name, description, and catalog/part number.
   b. Performance capabilities and operating requirements for each equipment and component item.
   c. Manufacturer catalog cut sheets and specification sheets for all equipment and components indicating sizes, ratings, materials of construction, standard features, options, accessories, etc.
   d. As-built shop drawings for all equipment and components, including fabrication and assembly drawings, panel drawings, wiring diagrams, and schematics.

2. Equipment Installation Requirements
   a. Complete, detailed installation instructions for each equipment and component item.

3. Equipment Operation
   a. Complete, detailed operating instructions for each equipment and component item, including sequence of operation addressing startup and shutdown, automatic operation, manual operation, and operating setpoint adjustments.
   b. Safety precautions, including explanations for all safety considerations relating to operations, and protective equipment and clothing requirements.
4. Equipment Service and Maintenance Data
   a. Maintenance data shall include all information and instructions required by District's personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions properly throughout its full design life.
   b. Unloading, handling, and long term storage requirements.
   c. Explanation with illustrations as necessary for each maintenance task.
   d. Recommended schedule of maintenance tasks.
   e. Alarms and troubleshooting instructions.
   f. Replacement parts list.
   g. List of maintenance tools and equipment.
   h. Name, address and phone number of manufacturer and manufacturer's local service representative.

5. User Manuals
   a. User manuals and application guides for all microprocessor based equipment and accessories, including but not limited to: pump control panel ultrasonic level controller.

6. Equipment Warranties

1.06 QUALITY ASSURANCE

A. The pre-engineered prefabricated wet well and valve vault shall be manufactured by Flygt (no substitutes).

B. Certain lift station components, including, but not limited to: valves, and wet well instrumentation may not be the manufacturer's standard supply. Contractor shall coordinate with the lift station manufacturer to ensure that the lift station components indicated on the Drawings, specified in other Specification Section, or specified herein are supplied and properly integrated into the lift station design.
C. Pumping units shall be guaranteed for a period of two (2) years. Refer to Specification Section 11073 and the Contract Conditions for the specific guarantee and bond requirements.

D. Aluminum access hatches shall be guaranteed against defects in materials and workmanship for a period of five (5) years.

PART 2 - PRODUCTS

2.01 PREFABRICATED WET WELL

A. General

1. The pre-engineered prefabricated wet well shall be capable of handling unscreened sewage or wastewater in accordance with the design conditions specified herein and indicated on the Drawings.

2. The wet well bottom and shaft shall be constructed of fiberglass reinforced plastic (FRP) as specified herein.

B. Design and Construction

1. The FRP wet well shall have an integral, hopper-shaped bottom, which is self-cleaning by virtue of its design. The flat surface area shall be minimized to an area that is directly influenced by the pump suction and shall be free of obstacles. The bottom surface area shall have a ratio of 1:4 as it relates to the cross-sectional area of the wet well. The sloping walls of the wet well bottom shall further optimize the self-cleaning features of this lift station by directing all solids, trash and sludge, normally found in sewage and wastewater, to the suction of the submersible pumps to facilitate removal and effectively clean the bottom.

2. The wet well shaft (cylinder) shall be affixed to the wet well bottom such that the assembled components are structurally integrated, resulting in a watertight vessel which shall be capable of withstanding the full hydrostatic head from the exterior of the wet well while it is completely empty. The cylinder shall be constructed of FRP using the filament winding process.

3. A safety factor of two (2) on the minimum ultimate tensile strength of the laminate bottom shall be used in designing the bottom and cylinder wall
thicknesses for the wet well, taking into account all normally imposed loads arising from flotation, soil pressures, normal backfill, handling loads, operating loads and static loads imposed by equipment used in hoisting the pumps in and out of the wet well.

4. The cylinder shall be a filament wound laminate constructed by saturating continuous strand glass roving in a controlled pattern over a corrosion resistant liner that shall be 110 mils minimum thickness. The rovings shall be applied uniformly throughout the entire length of the cylinder as required to provide adequate thickness for the mechanical loads of each application. The winding pattern shall be a combination of helical and hoop wraps and shall produce a dense laminate without non-reinforced resin pockets or air bridging between the rovings.

5. The glass content of the structural laminate shall be 60% to 70% by weight. The wet well bottom shall have a 30% to 50% glass content, chop spray laminate, constructed by built-up layers of chop spray and woven roving applied along with a catalyzed isophthalic resin. Each layer shall be properly wetted out and rolled out so that it is free of air voids until the required wall thickness has been obtained.

5. All inside surfaces shall be smooth and free of cracks and crazing. The inside surface shall be pigmented or gel coated to a bright white finish. All surfaces other than those made in contact with the mold surface shall be coated with air-inhibited resin or gel coat; including any cut edges of laminate.

6. The wet well shall be provided with one (1) anti-flotation flange located near the bottom of the structure. This anti-flotation flange shall be an integral part of the wet well and shall be sufficient in design to withstand the forces from subsoil water pressure acting upon the wet well from the bottom of the structure to finished grade.

7. Reinforced concrete shall be provided around the anti-floatation flange where shown on the Drawings and/or recommended by the manufacturer to provide adequate ballast against buoyancy under full hydrostatic head conditions (i.e. full hydrostatic head from exterior of wet well while the wet well is empty).
8. Shaft penetrations for piping and conduit shall be factory fabricated using FRP full circumference sealing hubs (sleeves) and threaded couplings, respectively.

a. Sealing hub and threaded coupling connections to the shaft shall be of hand lay-up construction and wrapped with sufficient glass fiber and resin to form an integral reinforced connection to the shaft wall. Connections to the shaft wall shall be either parallel to the horizontal axis of the shaft or perpendicular to the shaft wall, in accordance with the orientation shown on the Drawings.

b. Pipe sealing hubs shall be sized for the outside diameter of the specified piping and Link-Seal.

c. Link-Seal shall provide a watertight seal between the inside of the wet well hub (or sleeve) and the outside of the penetrating pipe. Link-Seal shall be provided with interlocking links of EPDM rubber and Type 316 stainless steel hardware.

d. Conduit penetration hubs shall be provided with threaded (NPT) full couplings for connection of underground conduit as shown on the Drawings.

e. Contractor shall coordinate all shaft penetration locations, elevations, and orientations with the PLSS. Field drilling and cutting of the wet well shaft for piping or conduit penetrations will not be allowed.

2.02 PUMPING UNITS

A. General

1. The pre-engineered prefabricated wet well shall be equipped with two (2) submersible non-clog wastewater pumping units. Refer to Specification Section 11073 for specific pumping unit requirements, including pump performance.

2. The pumps shall be automatically and firmly connected to the discharge connection, guided by no less than two (2) Type 316 stainless steel, non-sparking, guide rails (Schedule 40, minimum) extending from the top of the station to the discharge connection. Guide rails shall be provided with top, bottom, and intermediate (if necessary) support brackets. All
guide rail brackets and fasteners shall be constructed of Type 316 stainless steel.

3. The pump installation and removal system shall not require personnel to enter the wet well.

4. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring, or profile gasket will not be acceptable.

5. No portion of the pump shall bear directly on the wet well floor.

2.03 PREFABRICATED VALVE VAULT

A. General

1. The pre-engineered prefabricated valve vault shall be isolated (separate) from the wet well.

2. The valve vault bottom and cylinder shall be constructed of fiberglass reinforced plastic (FRP) as specified herein.

B. Design and Construction

1. The FRP valve vault size and internal piping layout shall permit entry for routine maintenance and inspection.

2. The valve vault shall be designed and fabricated in a manner that is identical to the wet well, including pipe penetrations.

3. The valve vault shall be provided with a flat bottom. Unless indicated otherwise, each valve vault shall be equipped with an integral drain and check valve to facilitate drainage from the valve vault back into the wet well.

2.04 ALUMINUM ACCESS HATCHES

A. Bars, angles and extrusions shall be constructed of 6061-T6 aluminum. Diamond plate shall be 1/4" (minimum) thick and shall be constructed of 5086 aluminum.

B. Access hatch units shall consist of single or double leaf covers, lower safety grate, cover and grate hinges, hold open devices, and appurtenances as specified
herein and as indicated on the Drawings. Access hatch units shall be prefabricated and fully assembled, inspected, and adjusted at the factory.

C. Unless specified otherwise, the wet well access hatch unit shall be provided with a double leaf cover, pump guide rail upper mounting brackets, and hooks for pump motor cable, float cable, level transducer cable, and pump lifting cable (4 minimum per pump).

D. Unless specified otherwise, the valve vault access hatch unit shall be provided with a single leaf cover and lower safety grates.

E. Access hatch unit covers shall be pedestrian rated for a minimum design load of 300 psf. Maximum deflection shall not exceed 1/150th of the span.

F. Access hatch safety grate assemblies shall be designed to provide fall through protection in accordance with OSHA Standard 1910.23. As a minimum, access hatch safety grates shall be designed to withstand a minimum live load of 300 pounds per square foot. Maximum deflection shall not exceed 1/150th of the span.

Access hatch safety grates for the wet well shall be designed to withstand a minimum live load of 300 pounds per square foot, plus the weight of the pumping unit (to facilitate pump wash-down procedures).

G. Hatch covers and safety grates shall be equipped with automatic hold open devices.

1. To provide increased visibility, the hold open arms for the hatch covers shall be supplied with a "safety red" powder coat finish.

2. Hatch covers and safety grates shall automatically lock open in the 90-degree position.

3. Hold open arms shall be fastened to the frame with a 1/2" diameter (minimum) Type 316 stainless steel bolts.

H. Hatch angle frame shall be constructed of extruded aluminum, with a continuous 3" bottom flange.

I. All hinges shall be of a heavy-duty design.

1. Hinges shall be constructed of stainless steel with 3/8" diameter (minimum) Type 316 stainless steel pins.
2. Hinges shall be bolted to the angle frame and diamond plate covers, with Type 316 stainless steel bolts and ny-lock nuts.

3. Aluminum hinges, or stainless steel hinges not utilizing 3/8” diameter or larger stainless steel pins will not be acceptable.

J. Hatch cover shall be provided with a Type 316 stainless steel recessed slamlock, equipped with a keyway protected by a threaded stainless steel plug.

1. Plug shall be flush with the top of the diamond plate cover.

2. Slamlock shall be fastened with four (4) Type 316 stainless steel bolts and washers.

K. Hatch cover shall be provided with a recessed padlock clip. The recessed padlock clip shall be supplied with its own separate cover for Owner access to an Owner supplied padlock.

L. Covers shall be equipped with recessed stainless steel lift handles. The lift handles shall be flush with the top of the diamond plate cover when not in use.

M. Wet well access hatch unit shall be provided with stainless steel upper mounting brackets for the pump guide rail system. All fasteners shall be constructed of Type 316 stainless steel.

N. Wet well access hatch unit shall be provided with 1/2” diameter hooks for hanging cables for the pump motor and wet well instrumentation, including associated stainless steel Kellums grips. As a minimum, four (4) hooks shall be provided per pump. Hooks shall be adequately spaced to accommodate excess coiled cable. Hooks, support brackets, and fasteners shall be constructed of Type 316 stainless steel.

O. Wet well access hatch unit shall be provided with an aluminum ground lug sized for a #6 AWG ground conductor cable. Ground lug location shall be coordinated with the conduit penetrations into the wet well, and grounding and bonding for the lift station grounding system.

P. Safety grates shall be constructed of 6061-T6 aluminum and designed per the "Specifications for Aluminum Structures", by the Aluminum Association, Inc., 5th Edition, December 1986 for "Bridge Type Structures".
Q. Access hatch unit shall be styled as a "Basin Cover Safe Hatch" to incorporate an aluminum plate cover to fully encapsulate the structure. Unless indicated otherwise on the Drawings, the outside diameter of the basin cover shall be 81", and shall consist of 1/4" (minimum) thick aluminum diamond plate.

1. Grate openings shall be 5" x 5", which shall allow for visual inspection, limited maintenance, and float adjustments while the safety grate fall through protection is lowered in place.

2. Design shall assure that the safety grating fall through protection is in place before the hatch cover doors can be closed; thereby, protecting the next operator. The hatch cover and safety grating leaf and hinge system shall not permit the hatch cover to be closed without ensuring the safety grating is in place.

3. Each safety grate shall be provided with a permanent hinging system. Grates shall be supplied with same hold open arm as covers (see above), and shall lock open in the 90 degree position.

4. Unless indicated otherwise on the Drawings, design shall be flush type with no hatch cover components or appurtenances extending above the top of the diamond plate cover.

5. Unless indicated otherwise on the Drawings, access hatch units shall be solid when closed, with no openings or threaded couplings penetrating through the diamond plate. A threaded coupling on the wet well access hatch unit for vent piping shall be omitted. However, manufacturer shall provide a factory drilled hole in the wet well access hatch for connection of the ultrasonic lever transducer pipe riser assembly, as shown on the Drawings.

6. Grates shall be media blasted with an abrasive aggressive enough to promote superior adhesion without altering end product finish. After blasting, grates shall receive a four stage cleaning that includes an etching process with ammonium bifluoride. Grates shall be coated with an OSHA type safety orange colored coating for visual awareness of the fall hazard. The aluminum safety grates shall receive a TGIC polyester powder coating, applied by the electrostatic spray process with a minimum thickness of 2-4 mils, and then be baked at 400 degrees F until a full cure is achieved.

R. All welding shall be in accordance with ANSI/AWS D1.2-90 Structural Welding Code for Aluminum.
2.05 PIPING, VALVES, AND SUPPORTS

A. Piping

1. All lift station sewage discharge piping and fittings shall be constructed of Type 316L stainless steel.

2. Unless indicated otherwise on the Drawings, sewage discharge piping shall be Schedule 40, and fittings shall be standard weight. All pipe and fitting joints shall be restrained. Unless indicated otherwise on the Drawings, joints shall be welded, flanged, or grooved. Flanged or grooved joints shall be provided where shown on the Drawings. Flanged fittings shall be provided with weld neck, ANSI B16.5, Class 150, flat faced flanges. Flanged piping shall be provided with slip-on or weld-neck, ANSI B16.5, Class 150, flat faced flanges.

3. Drain piping and air valve vent piping and fittings shall be Schedule 40 PVC.

4. All piping and fittings shall be provided in accordance with Section 15070, and as indicated on the Drawings.

B. Valves

1. Lift station discharge check valves shall be flanged swing check valves with outside levers and weights.

2. Lift station discharge isolation valves shall be flanged eccentric plug valves with lever operators.

3. Lift station discharge combination air valves shall be constructed of Type 316 stainless steel with threaded inlet and outlet.

4. Valves shall be provided in accordance with Section 15100, and as indicated on the Drawings. Please note, the Drawings require certain valves to be a specific model and manufacturer. These valves are identified with "no substitute" to the listed model and manufacturer.
C. **Supports**

1. All pipe and valve supports located in the wet well and valve vault shall be constructed of Type 316 stainless, including support members, plates, brackets, and fasteners.

2. Supports shall be properly located to facilitate pipe and valve installation and removal, to minimize pipe stress, and to prevent movement and vibration during lift station operation.

3. Support connections to the wet well and valve vault structure shall utilize Type 316 stainless steel brackets molded to the FRP surface with hand lay-up construction and wrapped with sufficient glass fiber and resin to form an integral reinforced connection to the structure.

### 2.06 PUMP CONTROL PANEL

A. **General**

1. The manufacturer shall furnish a pump control panel (PCP) that provides the proper control operation and electrical protection necessary for the automatic operation of the lift station and to preserve the special pump warranty. It is the intent of these Specifications that the electrical control and protection utilized for pump operation be supplied by the lift station and pump manufacturer to assure unit responsibility for equipment selection, sizing, component compatibility, startup, and operation.

2. The PCP shall be a duplex control panel designed and constructed for two (2) pumps. The PCP shall be factory wired and tested. Controls shall be provided to automatically start and stop the pumping units based on sewage level in the wet well, and to permit manual operation of the pumps at the panel.

3. As a minimum, the PCP shall be provided with the electrical protection and control components and functions shown on the power and control diagrams included in Appendix E of these Specifications.

B. **Design and Construction**

The PCP shall be factory wired and tested prior to shipment. The PCP shall include, but not be limited to, the following:

1. Incoming 480 VAC, 3-phase main power, and ground lug connections.
2. Thermal magnetic circuit breakers for the main power, primary and secondary sides of the 480 VAC to 120 VAC single-phase step-down transformer, and panelboard (120 VAC circuit breakers for PCP control power, remote telemetry unit, area lighting, GFI receptacle, and spare). Step-down transformer shall be dry type, high efficiency, 7.5 KVA. Panelboard circuit breakers shall be bolt-down type. Main power circuit breaker shall have a minimum interrupting rating of 25 kA.

3. Motor circuit protectors for each pump motor. Motor circuit protectors shall have a minimum interrupting rating of 25 kA.

4. NEMA rated magnetic starters with overload protection for each pump motor.

5. Hand-Off-Auto selector switches for each pump, including remote contacts.

6. LED, 30 mm, oil-tight, pilot lights (push-to-test) for pump run, high temperature, and seal fail, and common alarm).

7. Common reset push button for clearing alarm lights.

8. Elapsed time meter for each pump.

9. Motor high temperature and seal fail control module for each pump (Mini CAS 2).

10. Ultrasonic level controller suitable for automatic control of pump starting and stopping based on analog level, and capable of automatically alternating the "lead" and "lag" pump (automatic alternator). Refer to Section 17006 for specification requirements for the ultrasonic level measurement system, including level controller.

11. Intrinsically safe relays and barriers for the wet well high level floats.

12. 24 VDC power supply, if necessary, for intrinsically safe circuits.

13. Control relays and timers as required for pump control and status. Refer to Control Ladder Diagrams provided in Specification Appendix E.

14. 120 VAC GFCI convenience receptacle.
15. Terminal blocks as required for connection of pump and wet well level sensor conductors, and for connection of signals for remote status.

16. Wall mounted NEMA 4X enclosure suitable for all pump control panel equipment and components. The NEMA 4X enclosure shall be constructed of Type 316 stainless steel and shall be provided with painted steel back panel, padlockable 3-point latch, door stops, large inside door mounted data pocket, hinged full-size inner swing-out door, and grounding/bonding kit. The swing-out door shall be provided with captive screw fastened latches, shall be capable of being opened a full 90 degrees, and shall be grounded. All external hardware shall be constructed of stainless steel.

17. The inner swing out door shall be utilized for mounting selector switches, pilot lights, push buttons, elapsed time meters, convenience receptacle, ultrasonic level controller display, and padlockable handle operator for main power circuit breaker. All door mounted devices shall be provided with engraved identification nameplates. Nameplate inscriptions shall be approved by the District prior to fabrication.

18. All remaining control panel equipment and components shall be mounted to the back panel. DIN rails shall be provided for all rail mountable devices. Intrinsically safe devices shall be installed with the required UL 698A separations.

19. The PCP shall be manufactured in a UL 508A facility that is UL certified to manufacture panels with UL 698A intrinsically safe components. The completed PCP shall be UL labeled.

The PCP shall be provided in accordance with Section 16950 and the requirements specified herein.

**PART 3 - EXECUTION**

**3.01 FACTORY TESTS**

A. **Pumping Units**

1. Each completed and assembled pumping unit shall be factory tested in accordance with Section 11073.
2. Certified factory test reports shall be submitted and approved by the District prior to shipment of equipment.

B. **Pump Control Panel (PCP)**

1. The completed and assembled PCP shall be factory tested in accordance with Section 16950.

2. A certified factory test report documenting all control functions and data collected during factory testing shall be submitted and approved by the District prior to shipment of equipment.

### 3.02 MANUFACTURER'S SERVICES

Manufacturer shall provide services of trained and qualified service representatives for the furnished equipment and material. As a minimum, manufacturer services shall be provided for the following:

A. Manufacturer shall be onsite during the delivery of the prefabricated sewage lift station and accessories to supervise the unloading and inventory of the material and equipment. Manufacturer shall be onsite for at least one (1) eight-hour day.

B. Representatives shall be required to coordinate with the Contractor and provide technical supervision of the material and equipment installation. Minimum time onsite and number of trips to site shall be as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>Time Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Well</td>
<td>1 trip at 4 hours</td>
</tr>
<tr>
<td>Wet Well Backfill</td>
<td>1 trip at 4 hours</td>
</tr>
<tr>
<td>Valve Vault</td>
<td>1 trip at 4 hours</td>
</tr>
<tr>
<td>Wet Well and Valve Vault Piping</td>
<td>2 trips at 4 hours each</td>
</tr>
</tbody>
</table>

A written field report shall be prepared and submitted to the District for each trip.

C. Upon completion of installation, manufacturer representatives shall provide at least one (1) day (4 hours onsite) for the purpose of inspecting the installed equipment and accessories. The representatives shall notify District of anything in the installation which might render the manufacturer's warranty null and void. A written report shall be provided by the manufacturer's representative detailing same. Upon satisfactory completion of equipment installation, the manufacturer shall submit a Certificate of Proper Installation to the District.
D. The manufacturer shall provide representatives to perform startup, initial operation, and performance testing of the pumping units, pump control panel, instrumentation, and accessories. Said field services shall include a minimum of one (1) trip with eight (8) hours onsite. A written report shall be provided by the manufacturer's representative detailing the startup activities, system performance during initial operation, and performance testing results.

E. The manufacturer's representative shall instruct District's operating personnel as to the proper method of equipment operation, maintenance, and repair. A minimum of four (4) hours of training shall be provided. Operation and maintenance manuals shall be utilized and referenced during training of District personnel.

3.03 INSTALLATION

Installation shall be in accordance with the manufacturer's written instructions. As a minimum, Contractor shall install the prefabricated sewage lift station in accordance with the following requirements.

A. Wet Well and Valve Vault

1. Excavation

   The limit of excavation shall be such to allow for placing and removing forms, installing sheeting, shoring, bracing, etc. The Contractor shall pile excavated material in a manner that will not endanger the work and will not obstruct access to existing facilities or damage existing abovegrade improvements (e.g. landscaping, sidewalks, driveways, etc.). Excavated material stock piles shall not block surface drainage.

2. Vertical Sides

   When necessary to protect existing or proposed structures or other improvements, the Contractor shall maintain vertical sides of the excavation. The limit shall not exceed three (3) feet outside the wet well or valve vault shaft on a vertical plane parallel to the shaft wall, except where specifically approved otherwise by the Owner. The Contractor shall provide and install sheeting, shoring, and bracing as necessary to provide a safe work space as required to protect workmen, District's Inspector, structures, equipment, utilities, etc. The Contractor shall be responsible for the design and adequacy of all sheeting, shoring, and bracing. The sheeting, shoring, and bracing shall
be removed as the excavation is backfilled in such a manner as to prevent caving.

3. Sloping Sides

Where sufficient space is available, the Contractor will be allowed to back slope the sides of the excavation. The back slope shall be such that the excavation shall be safe from caving. The type of material being excavated shall govern the back slope used, but in any case the back slope shall be no steeper than 1 foot horizontal to 1 foot vertical.

4. Dewatering

The Contractor shall keep the excavation free from water by use of cofferdams, bailing, pumping, well pointing, or any combination as the particular situation may warrant. All dewatering devices shall be installed in such a manner as to provide clearance for construction, including, but not limited to: installation of piping, installation of forms and reinforcing steel, inspection of reinforcing steel and form work, placement of concrete, and removal of form work. It is the intent of these specifications that the crushed aggregate base beneath the wet well and valve vault be placed on a firm dry bed. The subgrade beneath the aggregate base shall be kept in a dewatered condition a sufficient period of time to scarify and recompact the subgrade, place and compact the aggregate base, install the respective FRP structure, and construct the concrete anchor ring for the wet well. All dewatering methods and procedures are subject to the approval of the Owner. The excavation shall be protected from excessive rainfall and surface drainage. The excavation shall be inspected and approved by the Owner before work on the structure may commence. It is the intent of these specifications that the Contractor provide a smooth, well compacted subgrade for placement of aggregate base, FRP structures, crushed rock, and concrete ring, as shown on the Drawings, without additional cost to the Owner, regardless of the soil conditions encountered. The Owner shall be the sole judge as to whether these conditions have been met.

5. Unauthorized Over-Excavation

Excavation for slabs, footings, etc., that bear on earth shall not be carried below the elevation shown on the Drawings. In the event the excavation is carried on below the indicated elevation, the Contractor shall bring the
bottom of the excavation to the required grade by filling with concrete having a minimum compressive strength of at least 3,000 psi at 28 days.

6. Handling

FRP structures shall not be dropped or impacted at any time during handling. FRP structures shall be chocked if stored horizontally. FRP structures shall be lifted as specified by the manufacturer. Use of chains or cables in contact with the FRP surface is prohibited.

7. Subgrade Preparation

Bottom of excavation shall be compacted to a minimum of 95% relative compaction. Crushed aggregate base shall be placed on the subgrade to the thickness and horizontal dimensions shown on the Drawings, and compacted to a minimum of 95% relative compaction. The FRP structure shall be lowered onto the crushed aggregate base and brought to plumb. Crushed rock wrapped with a non-woven geotextile shall be placed around the base of the wet well structure up to the anti-flotation flange. A reinforced concrete ring shall be constructed around the anti-flotation flange, as shown on the Drawings.

8. Backfill Material and Placement

Unless indicated otherwise on the Drawings, sand shall be used for backfill around the FRP structures for a distance of three feet from the outside surface and extending to approximately 18 inches from finished grade. Select fill material shall be used for the remainder of the backfill. Top soil should be stockpiled separately and used for finish grading around the structure top slab.

B. Pumping Units and Piping

1. No portion of the pump shall bear directly on the wet well floor.

2. Pump guide rails shall be provided with intermediate support braces as required to ensure smooth pump removal and installation.

3. All bolts, washers, nuts, etc. shall be constructed of Type 316 stainless steel.

4. Piping and valves shall be installed without imposing strain on equipment and valves.
5. All piping, fittings, valves and appurtenances shall be free of leaks. Any leaks that appear during initial operation and testing shall be promptly repaired by the Contractor.

3.04 FIELD TESTING

A. Prior to backfill, the wet well structure shall be hydrostatically tested by filling with water for 2 hours. Prior to filling with water, all pipe penetrations shall be provided with temporary plugs. No visible leakage will be permitted. All leaks shall be repaired per the manufacturer's recommendations.

B. All piping shall be hydrostatically tested per District Standards and as specified on the Drawings. Testing against valves is not permitted. Contractor shall provide temporary bulkheads, skilllets, and appurtenances as required for testing. All piping under concrete slabs/foundations shall pass pressure testing prior to placing concrete. No visible leakage is permitted in exposed piping.

C. Pumping units and the pump control panel shall be field tested in accordance with the requirements in the Sections for the respective equipment and in accordance with Section 01501.

3.05 INSTRUCTION

After the equipment has been installed, started up, tested, and adjusted, Contractor shall provide the services of a manufacturer's representative to instruct the Owner's operations personnel in the use and maintenance of the equipment. Unless specified otherwise, two (2) hours of instruction shall be provided for the pumping units and two (2) hours of instruction shall be provided for the pump control panel and instrumentation. The manufacturer shall provide a level of instruction which is adequate to train the Owner's personnel regarding use and maintenance of the equipment. During this instruction period, it shall be the responsibility of the manufacturer to answer any questions from the Owner's operating personnel. Cost for this instruction shall be included in the price bid.

END OF SECTION
SECTION 15070
PROCESS PIPING AND APPURTEANCES

PART 1 - GENERAL

1.01 DESCRIPTION

Pipe shall be furnished and installed as shown on the Drawings, and as specified herein.

Contractor shall furnish and install piping specialties as shown and specified, complete, including schedule carbon steel pipe, stainless steel pipe, copper tubing, PVC and CPVC pipe, brass pipe, mechanical and sleeve couplings, gaskets, bolts, insulating connections, and such other specialties as required for a complete and operable piping system in accordance with the requirements of the Contract Documents.

All piping, fittings, and appurtenances in contact with potable water, conveying water for a water treatment facility, or conveying chemicals for water treatment and/or disinfection, shall be certified per ANSI/NSF 61. All fittings and appurtenances in contact with potable water, conveying water for a water treatment facility, or conveying chemicals for water treatment and/or disinfection, shall be “lead-free” in compliance with Section 116875 of the California Health and Safety Code and lead-content certified per ANSI/NSF 372.

1.02 REFERENCE SPECIFICATION, CODES, AND STANDARDS

Commercial Standards (Latest Edition)

ANSI/ASME B1.20.1 Pipe Threads, General Purpose
ANSI/ASME B16.3 Malleable Iron Threaded Fittings Class 150 & 300
ANSI/ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ANSI/ASME B16.9 Factory-Made Wrought Buttwelding Fittings
ANSI/ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
ANSI/ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI/ASME B16.47 Large Diameter Steel Flanges: NPS 26 Through NPS 60
<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tbody>
<tr>
<td>ANSI/ASME B36.10</td>
<td>Welded and Seamless Wrought Steel Pipe</td>
</tr>
<tr>
<td>ANSI/ASME B36.19</td>
<td>Stainless Steel Pipe</td>
</tr>
<tr>
<td>ASTM A53</td>
<td>Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.</td>
</tr>
<tr>
<td>ASTM A105</td>
<td>Standard Specification for Carbon Steel Forgings for Piping Applications</td>
</tr>
<tr>
<td>ASTM A106</td>
<td>Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service</td>
</tr>
<tr>
<td>ASTM A153</td>
<td>Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware</td>
</tr>
<tr>
<td>ASTM A182</td>
<td>Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature</td>
</tr>
<tr>
<td>ASTM A193</td>
<td>Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and other Special Purpose Application Service</td>
</tr>
<tr>
<td>ASTM A194</td>
<td>Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both</td>
</tr>
<tr>
<td>ASTM A197</td>
<td>Standard Specification for Cupola Malleable Iron</td>
</tr>
<tr>
<td>ASTM A234</td>
<td>Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service</td>
</tr>
<tr>
<td>ASTM A312</td>
<td>Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes</td>
</tr>
<tr>
<td>ASTM A325</td>
<td>Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi, Minimum Tensile Strength</td>
</tr>
</tbody>
</table>
ASTM A351 Standard Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts

ASTM A380 Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

ASTM A403 Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings


ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM A967 Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

ASTM B32 Specifications for Solder Metal

ASTM B62 Specification for Composition Bronze or Ounce Metal Castings

ASTM B88 Specifications for Seamless Copper Water Tube


ASTM D1785 Standard Specification for Poly (Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120


ASTM D2657 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings

ASTM D2855 Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

ASTM D4894 Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials

ASTM F436 Standard Specification for Hardened Steel Washers


ASTM F441 Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80


AWWA C606 Standards for Grooved and Shouldered Joints
1.03 CONTRACTOR SUBMITTALS

Contractor shall prepare and submit complete and organized shop drawings and product data as specified herein and in accordance with General Conditions, Section F - Labor and Construction. Shop drawings and product data shall include, but not be limited to, the following:

A. A complete list of all materials to be provided under this Section.

B. Manufacturer's descriptive data, technical literature, and catalog cuts for each material item and appurtenance.

C. Fabrication drawings for each shop fabricated pipe spool, and associated pipe laying drawings for each piping system.

D. Manufacturer product data sheets, specifications, and installation instructions for solvent cements and primers to be used for socket joints in PVC and CPVC piping, fittings, valves, and appurtenances. Written statement from the piping and fitting manufacturer certifying the suitability of proposed solvent cements and primers for the specified chemical applications, process pressures, and ambient temperature range of 0 to 120 degrees F.

E. Where PVC or CPVC piping is specified, Contractor shall submit manufacturer's certification that pipe installers for PVC or CPVC piping systems are certified and trained in accordance with ASTM D2855 and the manufacturer's installation procedures.

PART 2 - PRODUCTS

2.01 SCHEDULE CARBON STEEL PIPE

A. Pipe

All dimensions and material thickness shall be in accordance with ANSI B36.10. Unless noted otherwise on the Drawings, schedule carbon steel pipe shall be as follows:

3 inch and smaller  ASTM A53 or A106, Grade B, Schedule 40, Seamless. Galvanized pipe shall be hot-dipped galvanized to ASTM A123
4 inch to 12 inch  
ASTM A53 or A106, Grade B, Schedule 40, Seamless or Electro Resistance Welded (ERW)

14 inch and larger  
ASTM A53 or A106, Grade B, Standard Weight, Electro Resistance Welded (ERW)

B. Fittings

Unless noted otherwise on the Drawings, carbon steel fittings shall be as follows:

All sizes  
Pressure rating no less than the connected pipe

3 inch and smaller  
ASTM A197, ANSI B16.3, Class 150 minimum. Fitting shall be threaded. Galvanized fittings shall be hot-dipped galvanized to ASTM A123 or A153

4 inch and larger  
ASTM A234, ANSI B16.9, Standard Weight, smooth-flow (mitered fittings are not acceptable). Fittings shall be flanged, welded, or grooved as shown on the Drawings.

C. Flanges

ASTM A105, ANSI B16.5 and B16.47 (Series A), Class 150, Slip-On or Weld Neck, Flat Face

D. Flange Bolting

Flange bolts shall conform to requirements of ASTM A325. Bolts shall be heavy hex head with length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut. Nuts shall comply with ASTM A194, Grade 2H, heavy hex pattern. Washers shall comply with ASTM F436, Type 1. Bolt threads shall be lubricated with an approved anti-seize compound.

E. Grooved Pipe and Fittings

Where specified on the Drawings, stainless steel grooved pipe and fittings shall be provided with roll or cut grooved ends as appropriate for pipe material, wall thickness, pressures, sizes, and method of joining. Grooved couplings shall be Victaulic Style 77 and 770, unless specified otherwise on the Drawings. Grooved coupling gaskets shall be as recommended by the manufacturer for the proposed fluid or gas.
F. Joints

Unless shown otherwise on the Drawings, schedule carbon steel piping 3 inch and smaller shall be joined by screwed joints and schedule carbon steel piping 4 inch and larger shall be joined by welded, flanged, or grooved joints.

2.02 STAINLESS STEEL PIPE

A. Pipe

All dimensions and material thickness shall be in accordance with ANSI B36.19. Unless noted otherwise on the Drawings, stainless steel pipe grade and schedule (thickness) shall be as follows:

- 3 inch and smaller: ASTM A312, Grade 316L, Schedule 40
- 4 inch and larger: ASTM A312, Grade 316L, Schedule 40

B. Fittings

Unless noted otherwise on the Drawings, stainless steel fittings shall be as follows:

- All sizes: Pressure rating no less than the connected pipe
- 3 inch and smaller: ASTM A351, Grade 316L, ANSI B1.20.1 Class 150 minimum, threaded
- 4 inch and larger: ASTM A403 and A774, Grade 316L, ANSI B16.9, B36.19, Schedule 40 (standard weight), Smooth-flow (mitered fittings are not acceptable). Fittings shall be flanged, welded, or grooved as shown on the Drawings

C. Flanges

- 3 inch and smaller: ASTM A182, Grade 316L, Thread-On, ANSI B1.20.1 and B16.5, Class 150, Flat Face.
- 4 inch and larger: ASTM A182, Grade 316L, Slip-On or Weld Neck ANSI B16.5, Class 150, Flat Face
D. **Flange Bolting**

All machine bolts, washers, and nuts shall be Type 316 stainless steel. Bolting shall conform to the requirements of ASTM A193, Grade B8M. Bolts shall be heavy hex head with length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut. Nuts shall comply with ASTM A194 heavy hex pattern. Bolts shall be provided with washers of the same material as the bolts.

E. **Grooved Pipe and Fittings**

Where specified on the Drawings, stainless steel grooved pipe and fittings shall be provided with roll or cut grooved ends as appropriate for pipe material, wall thickness, pressures, sizes, and method of joining. Grooved couplings shall be Type 316 stainless steel Victaulic Style 489, unless specified otherwise on the Drawings. Grooved coupling gaskets shall be as recommended by the manufacturer for the proposed fluid or gas.

F. **Joints**

Unless shown otherwise on the Drawings, stainless steel piping 3 inch and smaller shall be joined by screwed joints and stainless steel piping 4 inch and larger shall be joined by welded, flanged, or grooved joints.

### 2.03 HASTELLOY PIPE

A. **Pipe**

All dimensions and material thickness shall be in accordance with ANSI B36.10. Unless noted otherwise on the Drawings, hastelloy pipe grade and schedule (thickness) shall be as follows:

- 3 inch and smaller: ASTM B622, Grade C276, Schedule 40
- 4 inch and larger: ASTM B622, Grade 3C276, Schedule 40
B. **Fittings**

Unless noted otherwise on the Drawings, hastelloy fittings shall be as follows:

- **All sizes**
  - Pressure rating no less than the connected pipe
- **3 inch and smaller**
  - ASTM B366, Grade C276, ANSI B1.20.1 Class 150 minimum, threaded
- **4 inch and larger**
  - ASTM B366, Grade C276, Schedule 40 (standard weight), Smooth-flow (mitered fittings are not acceptable). Fittings shall be flanged, welded, or grooved as shown on the Drawings.

C. **Flanges**

- **3 inch and smaller**
  - ASTM B366, Grade C276, Thread-on, ANSI B1.20.1 and B16.5, Class 150, Flat Face.
- **4 inch and larger**
  - ASTM B366, Grade C276, Slip-On or Weld Neck ANSI B16.5, Class 150, Flat Face.

D. **Flange Bolting**

All machine bolts, washers, and nuts shall Type 316 stainless steel. Bolting shall conform to the requirements of ASTM A193, Grade B8M. Bolts shall be heavy hex head with length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut. Nuts shall comply with ASTM A194 heavy hex pattern. Bolts shall be provided with washers of the same material as the bolts.

E. **Joints**

Unless shown otherwise on the Drawings, hastelloy piping 3 inch and smaller shall be joined by screwed joints and hastelloy piping 4 inch and larger shall be joined by welded, flanged, or grooved joints.

### 2.04 Copper Tubing

A. Copper tubing shall conform to the requirements of ASTM B88 and shall be Type K, soft temper for buried tubing and hard-drawn for above-ground application. Unless specified otherwise, fittings shall be soldered or sweated on and shall be of cast bronze or forged brass containing 85 percent copper.
B. Joints shall be constructed with lead-free solder, 95-5 tin-antimony or tin-silver and shall conform to ASTM B32. For oxygen service, joints shall be made with silver solder.

C. Below grade copper tubing 2" in diameter and smaller shall be provided with an integral polyethylene coating. Polyethylene coating shall be extruded directly onto the tubing and shall have a minimum thickness of 25 mils.

D. Below grade copper tubing larger than 2" in diameter shall be encased with 8 mil (minimum) polyethylene. Ends of polyethylene encasement shall be sealed with two (2) full circumference wraps of 20 mil PVC tape.

E. All below grade copper fittings and non-coated copper tubing shall be wrapped with two (2) layers of 20 mil PVC tape.

F. Polyethylene coated copper tubing shall be Mueller Streamline, Kamco Aqua Shield, or equal.

2.05 PVC (POLYVINYL CHLORIDE) PIPE, SCHEDULES 40 AND 80

PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Normal Impact (Type I) to conform to the requirements of ASTM D1785, unless otherwise shown. Schedule 40 fittings shall conform to ASTM D2466, Schedule 80 socket fittings to ASTM D2467 and ASTM D2464 for threaded Schedule 80 fittings. Unless otherwise shown, joint design shall be for solvent-welded. Solvent cement shall conform to ASTM D2564 and primer shall conform to ASTM F656. Manufacturer shall confirm suitability of solvent cement and primer used for chemical applications. Where required for chemical applications, special chemical resistant primer and solvent cement shall be used (such as Weld-On P70 primer and 724 Orange solvent cement). Both pipe and fittings shall be the product of one manufacturer.

PVC Flanges shall be ANSI B16.5, Class 150, two-piece (Van-Stone style), socket conforming to ASTM D2467. Where required for higher pressure ratings, flanges shall be one-piece socket with corrosion-resistant steel backing ring assembly. Flange bolts shall conform to the requirements of ASTM A325. Bolts shall be heavy hex head with length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut. Nuts shall comply with ASTM A194, Grade 2H, heavy hex pattern. Washers shall comply with ASTM F436, Type 1. Bolt threads shall be lubricated with an approved anti-seize compound.
2.06 CPVC (CHLORINATED POLYVINYL CHLORIDE) PIPE, SCHEDULES 40 AND 80

CPVC pipe, for hot, corrosive solutions and where shown, shall be made from all new rigid unplasticized chlorinated polyvinyl chloride, Type IV, Grade 1 compound as stated in ASTM D1784, and shall be Schedule 40 (as minimum thickness) unless otherwise shown, and shall conform to ASTM F441. Fittings shall be the same schedule as the pipe. Schedule 80 socket fittings shall conform to ASTM F439 and ASTM F437 for threaded Schedule 80 fittings. Unless otherwise shown, joint design shall be for solvent welded construction. Solvent cement shall conform to ASTM F493 and primer shall conform to ASTM F656. Manufacturer shall confirm suitability of solvent cement and primer used for chemical applications. Where required for chemical applications, special chemical resistant primer and solvent cement shall be used (such as Weld-On P70 primer and 724 Orange solvent cement). Both pipe and fittings shall be the product of one manufacturer.

CPVC Flanges shall be ANSI B16.5, Class 150, two-piece (Van-Stone style), socket conforming to ASTM F439. Where required for higher pressure ratings, flanges shall be one-piece socket with corrosion-resistant steel backing ring assembly. Flange bolts shall conform to the requirements of ASTM A325. Bolts shall be heavy hex head with length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut. Nuts shall comply with ASTM A194, Grade 2H, heavy hex pattern. Washers shall comply with ASTM F436, Type 1. Bolt threads shall be lubricated with an approved anti-seize compound.

2.07 BRASS PIPE

Unless otherwise shown, brass pipe shall be seamless, Schedule 40, red brass pipe conforming to ASTM B43 and ASTM B687. Fittings shall be threaded, Class 125, cast red brass conforming to ASTM B584 and shall have a minimum copper composition of 85 percent. Flanges shall be ANSI B16.5, Class 150, threaded conforming to ASTM B43 and ASTM B687.

2.08 SLEEVE, FLEXIBLE, AND ADAPTER TYPE COUPLINGS

Couplings shall be of steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7 inches long for standard steel couplings, and 16 inches long for long-sleeve couplings. Bolts and nuts for exposed couplings shall be hot-dip galvanized. Bolts and nuts for buried or submerged couplings shall be of Type 316 stainless steel. Buried sleeve-type couplings shall be epoxy-coated at the factory as specified. Continuity bonds shall be provided as shown.
Where specified on the Drawings, couplings shall be harnessed to provide restraint. Harnesses shall conform to the requirements of AWWA Manual M11.

Lug material shall conform to ASTM A36 or ASTM A283 Grade C. Lug dimensions shall be as shown in AWWA Manual M11. Lugs shall be Type P for pipe sizes 6-inch to 10-inch diameter, and Type RR for pipe sizes 12-inch diameter and greater.

Couplings shall be provided where shown on the drawings and shall be Rockwell (Smith-Blair), Dresser, or equal.

2.09 GROOVED COUPLINGS

A. Carbon Steel and Ductile Iron Pipe

Where specified, mechanical grooved coupling shall be self-centering and shall engage and lock the grooved pipe and pipe fitting ends in place in a positive watertight couple. Coupling housing clamps shall be fabricated in two or more parts of ductile iron castings conforming to ASTM A536. Coupling assemblies shall be securely held together by two or more steel bolts and nuts of heat-treated carbon steel. Bolts and nuts shall be in accordance with ASTM A183 and A194, Grade 2. Couplings shall hold in place a gasket designed so that internal pressure serves to increase the seal's watertightness. Unless otherwise specified, gaskets shall be Grade "E" (EPDM) in accordance with ASTM D2000. Fittings shall be of grooved-end design to accept grooved mechanical couplings without field preparation.

Couplings for grooved schedule carbon steel pipe shall be Victaulic Style 77 and 770, or approved equal. Couplings for ductile iron pipe shall be Victaulic Style 31, or approved equal.

Unless shown otherwise on the Drawings, grooved couplings shall not be installed belowgrade.

B. Stainless Steel Pipe

Couplings 2 inches and larger shall be grooved end, rigid joint, Type 316 stainless steel, ASTM A351, ASTM A743, and ASTM A744. Gaskets shall be EDPM per ASTM D 2000 for water (NSF61 approved for potable water) and oil-free air to 230 degrees F, and nitrile for oil vapor in air and oil services to 108 degrees F. Bolting shall be stainless steel, ASTM A193, Grade B8M Type 316. Nuts shall be stainless steel, ASTM A194, Grade B8M, Type 316, Class 2, special anti-galling
coating. Couplings shall be pressure rated for the maximum pressure indicated on the Drawings.

Couplings for grooved stainless steel pipe shall be Victaulic Type 489, or approved equal.

Unless shown otherwise on the Drawings, grooved couplings shall not be installed belowgrade.

2.10 INSULATING CONNECTIONS

A. General

Insulating bushings, unions, couplings or flanges, as appropriate, shall be used for joining pipes of dissimilar metals, and for piping systems where corrosion control and cathodic protection are involved, or where specified on drawings. Insulating flanges shall be provided with full-faced gaskets, and insulating sleeves and washers for flange bolts.

B. Material

Insulating connections shall be of nylon, polytetrafluoroethylene (PTFE, trade name Teflon) polycarbonate, polyethylene or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.11 UNIONS

Unless specified otherwise, unions shall be constructed of the same material as the adjoining piping. Union pressure rating shall not be less than the connected pipe. Union seal material shall be compatible with the process fluid being conveyed by the piping.

2.12 PIPE INSULATION (FIBERGLASS FABRIC EXTERIOR SHELL)

Where specified or shown on the Drawings for pipe to be insulated, insulation shall be vitreous silicate fiber thermal insulation mat with asbestos free PTFE resin impregnated woven fiberglass fabric exterior shell. The exterior shell shall be top coated with pigmented PTFE. Insulation for valves, instrumentation, and appropriate appurtenances shall be per Section 15100. Insulation shall be suitable for outdoor installation in ambient temperature ranges of 0° to 120°F, weather proof, and UV resistant. Insulation cover shall completely cover piping and shall be capable of preventing process water from freezing. Insulation covers shall be provided with stainless steel lacing hooks and
tie wire or stainless steel buckles with Velcro straps to provide simple installation and removal. Insulation material shall be Treo as manufactured by Tritex, or approved equal, and exterior shell shall be 1650T as manufactured by Lewco Specialty Products, Inc., or approved equal. Insulation covers shall be factory pre-fabricated and shall be Fluor-O-Flo as manufactured by Insultech, or approved equal.

2.13 PIPE INSULATION (ALUMINUM SHEET METAL EXTERIOR SHELL)

Where specified or shown on the Drawings for pipe to be insulated, insulation shall be a molded-type pipe covering, made of fibrous glass with a minimum K-factor of 0.23 at 75°F. Unless specified otherwise, insulation shall be a minimum of 1" thick and shall completely cover all pipe, fittings, and appurtenances, including pipe and fitting flanges. Insulation shall have a factory-applied white fire-retardant vapor barrier of Kraft paper and aluminum foil laminated together and reinforced with fiberglass yarn. All insulation shall be weatherproofed with minimum 0.020 inch thick stucco-embossed aluminum jacketing. Jacketing shall be manufactured from ASTM B-209, Temper H-14 aluminum alloy. The jacketing for fittings shall consist of precision formed, stucco-embossed aluminum sections which shall be sized to cover and protect the insulated fitting. All joints shall be sealed with a silicone mastic to provide a continuous weather-tight joint. Strapping shall be 1/2" wide aluminum or stainless steel. Pipe insulation shall be as manufactured by Owens-Corning Fiberglass Corporation, Manville, or equal. Aluminum jacketing shall be as manufactured by Childers, RPR Products, Inc., or equal.

2.14 FLEXIBLE EXPANSION JOINTS

Flexible expansion joints shall be constructed of ductile iron per ANSI/AWWA C153 and shall consist of a center expansion joint with double ball-and-socket fittings, one on each side of the expansion joint. Each ball-and-socket fitting shall be capable of a minimum of 15 degrees of deflection and 4" of expansion and/or contraction, and additional expansion sleeves shall be added so that a 24" flex-tend has a total expansion of 16" (+12", -4"). Expansion joints shall be pressure tested to 350 psi minimum. Internal surfaces shall be epoxy-coated in accordance with ANSI/AWWA C213. Flexible expansion joints shall be Flex-Tend as manufactured by EBAA Iron, or equal.

2.15 FLEXIBLE HOSE AND TUBING

Flexible hoses and tubing shall be UV resistant, reinforced, and compatible with the fluid being conveyed, including for chemical service. Flexible hose and tubing and fittings/adapters shall be rated for the design pressure of the connected piping and a minimum ambient temperature of 120°F. Flexible hose or tubing shall be provided as shown on the Drawings and specified herein.
PART 3 - EXECUTION

3.01 GENERAL

In fabricating and installing pipe specified herein, a sufficient number of break-out connections consisting of unions (3 inch and smaller pipe), or flanged/grooved joints (4 inch and larger pipe) shall be installed to allow any section or run of pipe to be disconnected and removed without removing adjacent runs. In addition, at least one break-out connection shall be installed at every change in direction (horizontal and vertical) and adjacent to each valve. Unless shown otherwise on the Drawings, grooved joints will not be allowed in buried piping.

3.02 FABRICATION

Stainless Steel Piping Systems

A. All stainless steel piping systems shall be shop fabricated. Field fabrication of stainless steel piping will not be permitted. Piping layout and fabrication shall be as long as possible, while still allowing shipment.

1. Piping design indicated on the Drawings does not indicate the location of every joint and coupling that may be needed to connect piping sections fabricated in the shop.

2. Add joints and couplings in a manner that achieves intent of maximizing size of individual piping sections and meets requirements for break-out connections as specified herein.

3. All joints shall be fully restrained. Joints shall be welded, flanged, or Victaulic grooved couplings.

4. Weld seams with full penetration, free of oxidation, crevices, pits, and cracks and without undercuts. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

B. All stainless steel piping systems, sections, spools, fittings, and appurtenances shall be cleaned, pickled (descaler), and passivated at the point of manufacture or at a separate location that specializes in cleaning, descaling, and passivation.
of stainless steel. Field cleaning, descaling, and passivation will not be permitted. Stainless steel piping systems, sections, spools, fittings, and appurtenances shall include austenitic, ferritic, martensitic, duplex and super-duplex corrosion resistant steels. Cleaning, descaling, and passivation shall be performed as specified herein.

C. Descaling is the removal of heavy, tightly adhered oxide films resulting from hot-forming, heat-treatment, welding and other high temperature operations by means of chemical or mechanical methods. Passivation is the removal of exogenous (not inherent in the base metal) iron or iron compounds from the surface of stainless steel by means of a chemical dissolution, by a treatment with an acid solution that shall completely remove the surface contamination but will not significantly affect the stainless steel itself. All welds, heated areas of stainless steel parts, and heat affected zones of welds shall be cleaned, descaled, and passivated per ASTM A380 "Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems" and ASTM A967 "Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts" to prevent corrosion rates in excess of unwelded and unheated stainless steel base material. Descaling and passivation by use of pastes or sprays will not be permitted. Unless specified otherwise, passivation by means of electrochemical treatment, including electropolishing or electropolishing, will not be permitted. As a minimum, descaling and passivation shall include the following:

1. The surfaces of all stainless steel piping shall be thoroughly degreased and cleaned per ASTM A380. Surfaces shall be free of foreign material contamination (i.e. markers, chalk, paint, soil, grease, or oil). Cleaning solvents shall be non-chlorinated. Water-break testing per ASTM A380 shall be performed after cleaning to ensure all foreign material is removed prior to descaling. No break shall be permitted in the film as it drains from the vertical surface.

2. Upon successful completion of the cleaning process, all stainless steel piping shall be chemically descaled by complete immersion in a nitric-hydrofluoric acid solution bath. All surfaces shall be free of rust, free iron, weld scale, heat tint oxides, arc strikes, tool marks, gouges, and scratches that occurred in the procurement or fabrication stage. The finish of all stainless steel surfaces shall be of a high quality and as a minimum, equal to the milled or hot rolled condition specified by the material specification. Descaled surfaces shall be scrubbed and rinsed per ASTM A380.
3. Upon successful completion of the descaling process, all stainless steel piping shall be acid passivated for corrosion resistance and to provide a superior surface finish. All stainless steel piping shall be completely immersed in a nitric acid solution bath or a citric acid solution bath with additives at the proper concentrations, temperature, and duration as presented in ASTM A967. After each descaling and passivation treatment, stainless steel piping shall be thoroughly washed with a high pressure wash of clean cold potable water and allowed to air dry. Immediately, after first water rinse, the piping shall be thoroughly rinsed with a second potable water rinse. Finally, the piping shall be thoroughly rinsed with de-ionized water to remove residual halogens from all surfaces. The passivated piping shall exhibit a chemically clean surface and shall not show any pitting, etching, or frost. No heat tint or discoloration is allowed.

4. All stainless steel piping shall be tested to ensure corrosion resistance prior to shipment to site. As a minimum, the testing shall include the water immersion test and the salt water spray test or the potassium ferricyanide-nitric acid test per ASTM A967. Testing procedures shall follow ASTM A967 and shall be safe for potable water applications. Each test shall be recorded and presented in a report by an independent third party inspector paid for by the Contractor. Prior to shipment, a letter of certification and inspection reports from the third party inspection firm shall be provided to the Owner indicating the cleaning, descaling, and passivation procedures performed; test procedures performed including test results; and statements of certification that all work was performed in accordance with ASTM A380, A967, and as specified herein.

D. Assemble shop-fabricated piping in the field using the joints shown on the Drawings and designed into the piping layout.

3.03 INSTALLATION

A. General

All piping and appurtenances shall be installed as specified herein, per the manufacturers printed instructions, and as shown on the Drawings.

Exposed piping shall be installed as shown on the Drawings. Exposed piping shall be installed plumb and level and shall be routed parallel or perpendicular to structure walls, members, or lines. Exposed piping and appurtenances shall be supported from structure walls, floors, ceilings, and roofs with pipe supports as
specified on the Drawings and at intervals not exceeding maximum support spacing specified thereon.

Buried piping shall be installed as shown on the Drawings and in accordance with the Pipeline Technical Specifications or Provisions, and requirements specified herein. In the event of a conflict between requirements of the Technical Conditions, the most stringent requirements shall prevail. Buried piping shall be installed at the lines and grades shown on the Drawings. Where piping grades are not specified on the Drawings, buried piping shall be installed with a minimum of 30 inches of cover. Buried piping shall be installed in a trench condition with trench width not exceeding the pipe nominal diameter plus 6 inches. Unless specified otherwise, pipe zone backfill shall be clean imported commercial sand with a minimum sand equivalent of 30. The pipe zone shall extend from the bottom of the pipe trench to 12 inches over the top of the pipe. Unless specified otherwise, trench backfill above the pipe zone may be excavated trench material screened of debris and rocks greater than 3 inches in maximum dimension. Unless specified otherwise, pipe zone and trench backfill shall be compacted to a minimum of 90% relative compaction.

Pipe and equipment openings shall be closed with temporary caps or plugs during installation. Piping and equipment shall be protected from debris, water, chemical, and mechanical damage at all times during installation.

B. Schedule Carbon Steel Pipe

Cement mortar coated schedule carbon steel pipe shall be coated in accordance with the Pipeline Technical Specifications or Provisions. Field welding and cement mortar coating repair shall be performed in accordance with Pipeline Technical Specifications or Provisions.

Buried galvanized schedule carbon steel pipe shall be double wrapped with 20 mil PVC tape.

Buried black schedule carbon steel pipe shall be coated with 32 mils of a bitumastic coating prior to double wrapping with 20 mil PVC tape.
C. **Stainless Steel Piping Systems**

Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the work.

1. The pickled and passivated piping shall be packaged in a manner which shall afford protection of the piping from excess exposure during transit.

2. Handling methods and equipment used shall prevent damage to the surfaces and shall include the use of wide canvas slings and wide padded skids.

3. Bare cables, chains, hooks, metal bars, or narrow skids shall not be used.

4. After installation, the stainless steel piping shall be thoroughly washed with a high pressure wash of potable water and shall be free of dust or containments.

5. All stainless steel piping shall be covered during work performed in the vicinity of said components.

D. **Copper Tubing**

Below grade copper tubing larger than 2" diameter shall be installed with 8 mil (minimum) thickness polyethylene sleeves. Polyethylene sleeves shall be continuous, with all joints lapped 6" (minimum) and double wrapped with 20 mil PVC tape. Polyethylene sleeves shall be provided for all copper tubing encased in concrete. Polyethylene sleeves shall extend 3" above grade and ends shall be sealed with 20 mil PVC tape, double wrapped.

Copper tubing 2" in diameter and smaller shall be provided with integral polyethylene coating with 25 mil (minimum) thickness. Polyethylene coated copper tubing shall be Mueller Streamline, Kamco Aqua Shield, or equal.

All copper fittings and non-coated copper tubing shall be double wrapped with 20 mil PVC tape.

E. **PVC and CPVC Pipe**

PVC and CPVC pipe joints shall be primed and solvent-welded in accordance with ASTM D2855 and the manufacturer's instructions. Expansion joints or pipe
bends shall be provided to absorb pipe expansion over a temperature range of 100 degrees F, unless otherwise shown. Care shall be taken to provide sufficient supports, anchors, and guides, to avoid stress on the piping. Only clean, fresh primer and solvent-cement shall be used at any time. Contractor shall cure the solvent-cement in strict accordance with the manufacturer's requirements, including providing forced air ventilation.

Below grade PVC and CPVC piping shall be installed in a trench condition. Unless specified otherwise, pipe bedding and pipe zone backfill shall be clean imported sand with a minimum sand equivalent of 30.

PVC and CPVC piping specified to convey chlorine gas shall be installed in accordance with Chlorine Institute recommendations, including cleaning, drying and purging prior to the introduction of chlorine gas into the piping system.

F. **Unions**

In erecting threaded, socket welded, or butt welded pipe smaller than 4" diameter, a sufficient number of unions shall be installed to allow any section or run of pipe to be disconnected without taking down adjacent runs. In addition, at least one union shall be installed at every change in direction (horizontal and vertical) and adjacent to each valve. Unless specified otherwise, the union material shall match the piping material.

G. **Couplings**

Pipe couplings shall be installed in strict accordance with the manufacturer's printed recommendations. Buried couplings shall be polyethylene encased in accordance with AWWA C105/A21.5-99.

H. **Gaskets for Flanged Joints**

Unless specified otherwise, gaskets shall be full-faced and shall be constructed of cloth-rubber or fiber sheets (no asbestos allowed). Gaskets shall be certified per ANSI/NSF 61 and shall be rated for a minimum working pressure of 800 psi. Wherever blind flanges are shown, gaskets shall cover the entire inside surface of the blind flange and shall be cemented to the surface of the blind flange.

I. **Insulating Connections**

All insulating connections shall be installed in accordance with manufacturer's printed instructions. Unless shown otherwise on the Drawings, all insulating
connections shall be provided with cathodic protection test wires on both sides of the connection for monitoring and testing purposes. Test wires shall be extended to the ground surface and terminated in a precast concrete meter box. Meter box shall be provided with a cast iron cover labelled "C. P. Test Station".

3.04 CONTINUITY BONDS

Where required by the Drawings, all joints, except field-welded joints and insulating joints, shall be continuity bonded. Bonds shall be welded to the pipe as shown, as well as all major parts of any couplings used. Bonds shall be inspected and approved by the Owner before the exterior of the pipe joint is coated. The bond shall be completely covered with protective coating material prior to backfilling of the trench.

3.05 INSULATION COVERS

Contractor shall field measure all piping and appurtenances required to be insulated prior to manufacturer constructing insulation covers. Manufacturer shall provide instruction to Contractor if field altering of insulation covers is required.

3.06 FIELD HYDROSTATIC TEST AND LEAKAGE TEST

A. Hydrostatic Test

Upon completion of piping installation, piping and appurtenances shall be filled with water for twenty-four hours minimum. During filling, Contractor shall see that all air valves are open and operating. After piping has been completely filled, they shall be allowed to stand for twelve hours minimum under slight pressure for sufficient time to permit all air to escape. During that same period, Contractor shall examine all fittings, flanges, and connections for leaks. If any leaks are found, they shall be eliminated.

Unless specified otherwise, test pressure, 225 psi minimum for Class 150 pipe and 150 percent of pipe class or working pressure rating for other classes of pipe, shall then be applied to test sections as directed by the Owner. Test pressures shall be maintained for four hours minimum. Test sections will be selected which give, as nearly as possible, constant pressure throughout section being tested. Normally test pressures will be measured at lowest elevations.

B. Leakage Test

After hydrostatic pressure test has been satisfactorily completed, piping and appurtenances shall be tested for leakage at pressure equal to the pressure class...
of pipe or working pressure rating of pipe. Contractor shall test piping and appurtenances in test sections as designated by the Owner and required pressures shall be maintained for two hours minimum during which time leakage shall be monitored. No leakage will be allowed for exposed piping and appurtenances. Any leakage for buried piping shall be accurately measured, and shall not exceed the limits set by the following formula unless otherwise specified by the Drawings.

\[
L = \frac{N D (P)^{1/2}}{5000}
\]

*L* is the allowable leakage in gallons per hour for section of piping being tested; *N* is the number of joints (rubber gasket, flanged, or threaded joints, not welded joints) where leakage could occur in the section of piping being tested; *D* is the nominal diameter (inches) of the piping being tested; and *P* is the weighted average test pressure (psi gauge) within the section of piping being tested during the leakage test.

C. General Requirements

1. Required test pressures shall be applied by pump connected to piping sections being tested. The Owner shall approve pump connections to piping before testing begins. As part of the Work, and unless specified otherwise, Contractor shall install, at his expense, top outlets (service taps) required for testing.

Contractor shall provide calibrated meters for measurement of leakage, and all pumps, piping, fittings, bulkheads, plugs, valves, gages, power equipment, and manpower necessary for conducting all tests required, all at his expense. Contractor shall furnish the Owner three copies of all records of all tests performed.

2. Unless specified otherwise, Contractor shall test against test plates for piping 12 inches and smaller. Contractor shall not remove said test plates until piping has been tested, disinfected (if applicable), and accepted by the Owner.

3. Contractor, at his expense, shall locate and repair leaks or other defects which may develop or become apparent during test. For buried piping, Contractor shall excavate, including removal of backfill already placed, and make all repairs necessary for required water tightness, and then replace all excavated material, after which Contractor shall retest
repaired piping section. Piping sections shall be repeatedly repaired and tested until they meet requirements set forth herein.

3.07 DISINFECTION OF PIPING AND APPURTEANCES

All piping, fittings, and appurtenances in contact with potable water, conveying water for a water treatment facility, or conveying chemicals for water treatment and/or disinfection shall be properly disinfected prior to being placed into service or connected to existing piping. Contractor shall furnish all equipment, labor, and materials for the proper disinfection (chlorination and flushing) of all specified piping and appurtenances. Upon completion of the disinfection process, Contractor shall neutralize all disinfection water prior to its disposal.

Unless specified otherwise, Contractor shall disinfect piping and appurtenances in accordance with Specification Section 15041.

END OF SECTION
SPECIFICATIONS - DETAILED PROVISIONS
Section 15081 - Gaskets

CONTENTS

PART 1 - GENERAL .............................................................................................................................1
  1.01 REQUIREMENT .........................................................................................................................1
  1.02 FLANGE INSULATING GASKET KITS ......................................................................................1
PART 1 - GENERAL

1.01 REQUIREMENT
Gaskets for steel and cast iron flanges shall be of dimensions conforming to the requirements of Standard Drawing B-288, and shall be standard full face for pipe 27" diameter and larger.

Gaskets shall be 1/16", non-asbestos model # Garlock 3000 or Tripac 5000.

1.02 FLANGE INSULATING GASKET KITS
A. Pipe flange insulating kit materials shall be of the type designated by the manufacturer as suitable for appropriate service at the operating temperatures and pressures specified on the Plans.

B. Flange insulating kits shall consist of a one piece full-face, insulating gasket, an insulating sleeve for each bolt, two insulating washers for each bolt, and a steel washer between each insulating washer and nut.

1. Insulating gasket shall be a full faced NEMA Grade G-10 Glass Epoxy Laminated Retainer with a precision tapered groove to accommodate the compression of a BUNA-N or VITON sealing element. Minimum total thickness shall not be less than 1/8-inch. Dielectric strength shall be not less than 550 volts per mil, and compressive strength of not less than 50,000 psi. Use PSI Linebacker or equal.

   a. Optional Materials:
      1. Neoprene faced phenolic gasket

2. Insulating sleeves shall be full length, one piece, insulating flange bolt sleeves for the appropriate bolt size. Insulating sleeves shall be NEMA G-10 Glass Epoxy Laminated tubing (Pyrox). Dielectric strength shall be not less than 400 volts per mil.

   a. Optional Materials:
      1. Phenolic tubing
      2. Nomex tubing
      3. Mylar tubing
      4. Polyethylene tubing

3. Insulating washers shall be NEMA Grade G-10 Glass Epoxy Laminated Washers with a minimum thickness of 1/8-inch. Dielectric strength shall not be less than 550 volts per mil, and compressive strength of not less than 50,000 psi.
a. Optional Materials:
   1. Phenolic Washers
   2. Nomex Washers

4. Provide cadmium plated steel flange bolt washers for placement over the insulating washers with a minimum thickness of 1/8 inch.

END OF SECTION 15081
PART 1 - GENERAL

1.01 REQUIREMENT

1.02 USE OF ZINC CAPS FOR BURIED PIPE
PART 1 - GENERAL

1.01 REQUIREMENT
Bolts and nuts for flanged fittings shall be bare steel conforming to SAE J429 Grade 5 or ASTM A449 medium carbon steel quenched and tempered meeting the following requirements, and shall have hex heads and lite-pattern hex nuts.

\[\frac{3}{8}'' \text{ Through 1'' diameter}\]
- 85,000 p.s.i. proof strength
- 92,000 p.s.i. yield strength
- 120,000 p.s.i. tensile strength

\[\text{Over 1'' to 1}\frac{1}{2}'' \text{ diameter}\]
- 74,000 p.s.i. proof strength
- 81,000 p.s.i. yield strength
- 105,000 p.s.i. tensile strength

1.02 USE OF ZINC CAPS FOR BURIED PIPE
Each bolted fitting including couplings, flange adapters, restrained joints, etc. that have manufactured bolts and nuts shall have a minimum of 2 zinc caps anodes as specified below.

Bolt sizes and number of zinc caps:
- through 1'' diameter - 2 zinc caps
- over 1'' diameter - 4 zinc caps

Weight of zinc caps:
- Zinc caps to be 6 oz. weight.

Material reference:
- Zinc caps shall be per ASTM B418-80 and Mil-A-18001J, and be manufactured by Mars, Reliance, or equal.
SECTION 15100
PROCESS VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

Valves shall be as specified by these Specifications and as may be modified by the Special Provisions, other Technical Specifications, or the Drawings. Where "Owner's Approved Materials List" is incorporated within the Contract Documents, only manufacturers listed therein shall be acceptable. Contractor shall provide all tools, supplies, materials, equipment, and labor necessary for furnishing, interior epoxy coating, exterior coating, installing, adjusting, and testing of all valves, valve operators, and appurtenant work, complete and operable, as specified herein and shown on the Drawings. Where buried valves are shown, the Contractor shall furnish and install valve boxes to grade, with covers and extensions per Standard Drawings.

All valves in contact with potable water, conveying water for a water treatment facility, or conveying chemicals for water treatment and/or disinfection, shall be certified per ANSI/NSF 61. All valves in contact with potable water, conveying water for a water treatment facility, or conveying chemicals for water treatment and/or disinfection, shall be "lead-free" in compliance with Section 116875 of the California Health and Safety Code.

1.02 PROJECT SPECIFIC REQUIREMENTS

Unless otherwise specified herein or on the Drawings, all valves shall be rated for a minimum working pressure of 150 psi.

Unless otherwise specified above, on the Drawings, or by other Technical Specifications, all other valves shall be provided as specified herein.

1.03 SUBMITTALS

A. Shop Drawings

Contractor shall submit shop drawings in accordance with the General Conditions, Section F - Labor and Construction. Contractor shall submit complete information and technical data for all material and components, including, but not limited to, the following: fabrication, assembly, detailed specifications and data covering performance and materials of construction,
parts, installation instructions, coatings, operators, valve boxes, extensions, and other pertinent data. Shop drawings shall clearly indicate size, end connections, and proposed service condition, as well as special features required for buried service.

B. **Operation and Maintenance Manual**

Contractor shall submit for each valve a detailed operation and maintenance manual in accordance with the General Conditions, Section F - Labor and Construction, and Detailed Provisions, Specification Section 01430.1.

1.04 **QUALITY**

A. All valves furnished under this Section shall be of a design and manufacture that has been used in similar applications. Manufacturers specified herein manufacture valves with acceptable quality or experience.

Manufacturers must, however, provide written confirmation that valves to be supplied meet the performance requirements specified herein and are suitable for long term operation with the proposed fluid.

B. All valves of a particular type shall be by one (1) manufacturer. In addition, valve operators for a particular type of valve shall be by one (1) manufacturer.

C. Contractor shall coordinate valves furnished with connecting piping or equipment to ensure compatible end connections and proper valve operation.

**PART 2 - PRODUCTS**

2.01 **PRESSURE RATING**

All process valves shall be rated for a working pressure equal to (or more than) the pressure rating of the connecting piping, minimum of 150 psi, or as specified otherwise herein or on the Drawings.

2.02 **VALVE TAGS**

Each and every valve shall be provided with a 14 gauge brass indexing tag, 1-1/2" diameter, bearing 3/16" die-stamped lettering with pipe duty designation and valve number. Exact lettering and numbering shall be as approved by Owner. Each tag shall be securely attached to its valve with a #10 single-jack brass chain or with brass bolts or
screws. Each tag shall be provided with two holes for securing tag with chain, bolts, or nails. Buried valves shall have tags attached to valve box.

2.03 OPERATORS

A. General

The operators shall be sized based on the maximum expected torque as per the valve manufacturer's recommendations. The responsibility for selection of proper operator and the valve operation therewith shall reside with the valve manufacturer/supplier. Unless noted otherwise, the differential pressure for opening and closing the valve shall be 150 psi.

B. Manual Operators

Manual operators, except where otherwise shown or specified, shall be worm-gear type, Limitorque T100, E-I-M Type MG, or equal and shall conform to AWWA C504, Section 3.8. The axis of the worm shaft shall remain fixed during operation. A visual OPEN/CLOSED indicator shall be an integral part of the operator. A handwheel shall be provided except where an extension stem and floor stand or valve box, tee wrench, and street box are required. Handwheels shall have OPEN and CLOSE directional arrows cast on the outer rim. Unless otherwise specified, handwheels shall have a minimum diameter of 8". Extension stems and accessories shall be sized for valve manufacturer's recommendations.

1. Gate and Globe Valves

All gate, globe, and angle valves shall be fitted with cast iron handwheels of suitable size or gear operators in accordance with AWWA C504, Section 3.8.

2. Butterfly Valves

All butterfly valves 3" and smaller in size shall be lever and locking ratchet operated and valves 4" and larger in size shall be equipped with enclosed gear and handwheel operators. The operators shall be furnished by the manufacturer of the valve, in accordance with AWWA C504, Section 3.8, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operators shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be used. Buried or submerged valves shall conform to AWWA
C504, Section 3.8.5.3 and have properly constructed actuators for the service.

3. Plug and Ball Valves

All plug and ball valves 3" and smaller in size shall be lever and locking ratchet operated and plug valves 4" and larger in size shall be provided with enclosed gear and handwheel operators unless otherwise shown or specified. Buried or submerged valves shall conform to AWWA C504, Section 3.8.5.3 and have properly constructed actuators for the service.

4. Chainwheel Operator

All valves 6' or more above the floor level shall be provided with chainwheel operators in lieu of the handwheel operator and shall be the valve manufacturer's standard, with galvanized chain to be furnished in the length required for operation. Chainwheel operators shall conform with AWWA C504, Section 3.8.5.2.

5. Wrench Nut Operation

An AWWA nut or shaft key, as applicable, shall be provided in lieu of handwheel where required for connection to extension stem and floor stand or for buried valves. Nut shall be 2" square and shall have a flanged base upon which shall be cast an arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange. No submerged or buried operator shall require maintenance following installation. Suitable gaskets, O-rings, and other features shall ensure permanent water tightness. Operator shall be designed to take the load of the shaft extension.

C. Electric Operators

Where electric type operators are specified, an electric motor-operated valve control unit shall be attached to the valve operation mechanism housing by means of a flange motor adapter piece. Operator unit shall include the motor, operator unit gearing, torque switches, limit switches, auxiliary handwheel, starter, mechanical position indicator and accessories to provide a complete and operable unit. Electric operators shall conform to AWWA C540. The valve actuator motor and all electrical enclosures shall be weatherproof, NEMA 4, as a minimum. When specified, motor and all electrical enclosures shall be available to meet NEMA 6 submersible or NEMA 7 hazardous requirements. Valve
manufacturer/supplier shall be responsible to ensure proper selection and operation of valve/operator assembly. Electric operator shall be designed for open-close operation or modulation, as specified, or as shown on the Drawings.

1. Gearing

The power gearing shall consist of spur or helical gears of hardened alloy steel and worm gear of alloy bronze. All power gearing shall be grease or oil lubricated, in a sealed housing. Ball or roller bearings shall be used throughout.

2. Non-Modulating

A lost-motion starting device independent of gear backlash shall be supplied as an integral part of the actuator gear train. This device shall allow the motor to attain full speed before the load is engaged. The lost-motion device shall not be incorporated in actuators supplied for modulating service.

3. Motor

The motor shall be of the totally-enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. Unless otherwise specified, motor shall be suitable for operation on 480 volt, 3 phase, 60 hertz current, and have Class H insulation. The motor shall have a running torque per valve manufacturer's recommendation, and be of sufficient horsepower to open or close a valve against the maximum specified differential pressure when voltage to the motor is ±10% of nominal voltage with a factor of safety of 1.5. The motor shall be pre-lubricated and all bearings shall be of the anti-friction type. Motor rating shall be 30 minute duty.

4. Limit Switches

Limit switches and their gearing shall be an integral part of the valve operator. The limit switch compartment shall be totally enclosed and equipped with a heater and thermostat to prevent build-up of moisture and contamination. Switches shall be SPDT and rated 10A at 120 VAC or as specified. The actuating point shall be adjustable at any point of valve travel between fully open and fully closed. Unless specified otherwise, limit switches shall be provided to indicate valve open and valve closed.
5. Torque Limiting Switches

Torque limiting switches shall be provided and be responsive to the mechanical torque developed in seating, backseating, or by obstruction. The torque switch shall operate a calibrated dial integrally mounted and directly related to the torque output of the operator. Torque control accuracy shall be within ±5%. The use of torque wrenches for calibration shall not be required. A calibration tag stating the maximum torque output of each torque switch at 100% setting shall be permanently affixed to the torque switch dial. The torque switch shall be calibrated by use of a dynamometer in order to accurately predict the output of the actuator.

6. Handwheel Operation

A permanently attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions specified herein shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lbs. An arrow and either the word OPEN or CLOSE shall be cast on the handwheel to indicate the direction to turn said handwheel. Unless otherwise specified, handwheels shall have a minimum diameter of 8".

Electric operators shall be as manufactured by Limitorque, EIM, AUMA, Pratt, Keystone, or equal.

D. Pneumatic Operators

Where pneumatic type operators are specified, a totally enclosed pneumatic rotary actuator shall be directly attached to the valve mounting flange or top plate, without the use of special brackets, linkage or couplings. The actuator shall be of the rack and pinion type, providing constant output torque throughout travel. All units shall be factory tested to insure proper operation, and factory lubricated for actuator service life. A smooth, self-draining body shall be provided to resist moisture. The actuator shall have integral porting to eliminate external tubing. Localized mechanical position indication shall be provided and be readable from a distance of 25' by use of contrasting colors. The standard operation shall be 0-90° reversible operation for air, gas or hydraulic oil. Actuator shall be capable of operating in any valve mounting
attitude, and capable of being mounted either in line or transverse to the pipeline.

Spring return shall be available for fail-safe conditions. The spring return actuator shall be capable of providing "fail-open" or "fail-closed" as required. Standard actuators shall be designed so that the spring return option can be added at a later date. Valve manufacturer/supplier shall be responsible to ensure proper selection and operation of valve/operator assembly.

1. Materials of Construction

The actuator body, end caps, and spring cartridge housings shall be made of precision extruded, hard anodized aluminum. The pistons shall be a hard anodized aluminum alloy. The actuator drive shaft and pinion shall be of hardened and tempered alloy steel. All fasteners shall be electroless nickel-plated. The piston seals and "O" rings shall be made of nitrile rubber. The bushings shall be acetal plastic for maximum efficiency and elimination of galvanic action.

2. Service Requirements

The actuator shall be suitable for operation in temperatures ranging from -13° to 200°F. The actuator shall be designed for pneumatic operation up to a maximum pressure of 125 psi. Filtered air shall not be required for proper operation. The actuator design shall have been tested for a minimum 100,000 cycles under full load with no appreciable wear of parts.

3. Accessories

Where specified or shown, the following pneumatic operator accessories shall be provided:

a. Solenoid Valve

The solenoid valve shall be capable of being mounted directly over the actuator air ports. Unless otherwise specified, solenoid valves shall have a NEMA 4 enclosure. The solenoid valve shall be provided with a manual override (with automatic reset capability) which allows manual operation in the event of power failure. An adjustable speed control shall be provided where specified. Solenoid housings shall be provided with a 1/2" NPT conduit
entry. The solenoid valves shall operate at 120 volts AC, 60 hertz, single phase.

b. Limit Switches

The limit switches shall be single pole, double throw, cam operated, adjustable throughout the 90° travel range, and rated at 15 amps for 125 or 250 VAC. Limit switches shall be pre-wired to an internal terminal strip, and conduit entry shall be 3/4" NPT. Unless otherwise specified, limit switch housing shall be rated NEMA 4. The limit switch box shall be mounted directly to the upper actuator housing.

c. Spring Return

The spring return (fail safe) option shall be of the retained, or safety cartridge type, to allow convenient and safe disassembly. Springs shall be hard drawn and annealed tempered steel.

d. Positioner

The positioner shall mount to the top of the actuator housing, and be of the rotary type, with a standard input range of 3-15 psig and with an option of 3-9, 9-15, 15-3, 15-9 psig split-range operation. The positioner shall operate on a maximum supply of 150 psig. Air consumption shall not exceed 0.7 standard cubic feet per minute in balanced condition with 60 psig supply pressure. The positioner shall be furnished with three (3) pressure gauges and all necessary mounting hardware, as a complete package.

e. Travel Stops

Travel stops for the actuator shall consist of a mounting plate, with stop cam, fitted between the base of the actuator and the valve mounting flange, and shall be externally adjustable through the full 90° of valve travel.

Pneumatic operators shall be as manufactured by Keystone, DeZurik, or equal.
2.04 PROTECTIVE COATINGS

A. Interior

All interior non-working ferrous surfaces other than stainless steel shall be given an epoxy coating unless specified otherwise.

1. All valves shall be fusion bonded epoxy coated (8 to 12 mils) in accordance with AWWA C550 (latest). Owner shall approve epoxy coating materials and methods before application. Completed coating shall be free from all defects and shall be inspected by use of low voltage holiday detecting and non-destructive thickness gauges.

2. Where the manufacturer demonstrates in writing that it would be impossible to use the powder epoxy method without causing damage to the valve components, the use of a liquid epoxy will be permitted upon approval by the Owner.

3. If small local repairs are necessary, they shall be made using a liquid epoxy recommended by the manufacturer of the epoxy with which the item was initially coated. The surface shall first be hand tool cleaned in accordance with SSPC-SP2. The repair epoxy material shall be applied in accordance with the manufacturer's instructions.

4. Where factory hydrostatic testing of the valve is required the valve shall pass all tests prior to interior coating applications.

B. Exterior

All valves shall be given a shop prime coating which shall be compatible with the field applied coating system.

1. Buried Valve

Unless specified otherwise, all buried ferrous valves and any ferrous materials (e.g. flange bolts and nuts, restraining glands, and T-bolts and nuts) shall be coated with bitumastic coating of not less than 32 mils. Prior to coating, all surfaces shall be prepared in accordance with SSPC-SP3 and manufacturer's recommendations. The two coat system shall be Tnemec 46-450, Carboline Bitumastic 50, or equal.
2. Nonburied and Immersed Valves

All valves shall be coated as specified in Section 09900, and as shown on the Drawings.

2.05 ECCENTRIC PLUG VALVE

Eccentric plug valves shall be of the non-lubricated eccentric type with round or rectangular port design unless otherwise specified. The valve body and plug shall be constructed of cast iron meeting the requirements of ASTM A126, Class B. Valve bearing shall be constructed of corrosion resistant stainless steel. Unless otherwise specified on the Drawings, the entire plug shall be completely encapsulated with Buna N rubber. Unless otherwise shown or specified on the Drawings, the valves shall be flanged with dimensions, facing, and drilling in full conformance with ANSI B16.1, Class 125. With the plug in the full open position, valve opening shall be 100% full port, valve shall have no cavities where debris can collect, have minimal head loss, and be capable of passing a clean out pig with the same nominal diameter as the adjacent pipe. Valves shall be equipped with operators as shown on the Drawings and as specified herein. All eccentric plug valves shall have a pressure rating of not less than 150 psi, for bubble tight shut off. Valves shall be the product of a single manufacturer and shall be DeZurik or Pratt (no substitutes).

2.06 FLANGED BUTTERFLY VALVES

A. Ductile Iron Discs

All butterfly valves shall be short pattern, flanged, designed and manufactured in accordance with AWWA C504 (latest) unless otherwise specified herein or shown on the Drawings. Valve body, disc, and flanges shall be constructed of heavy duty ductile iron meeting the requirements of ASTM A536 Grade 65-45-12. Flanges shall be drilled in accordance with ANSI B16.1 standards (Class 125) and shall be of the short body design. The disc shall have a 316 stainless steel or Ni Chrome edge and be securely attached to a 316 stainless steel shaft with stainless steel pins. Valves shall have sleeve-type nylon bearings and a resilient seat of Buna N (or equal) material mounted in the valve body. Valves shall be rated for a minimum working pressure of 250 psi unless otherwise specified. Valves shall be equipped with operators as shown on the Drawings and as specified herein. Butterfly valves shall be the product of a single manufacturer which shall be DeZurik, Pratt, or equal.
Where Class 250 or Class 300 valves are specified on the Drawings, they shall be of similar construction to AWWA C504 butterfly valves specified above, but shall be furnished with Class 250 flanges.

**B. Stainless Steel Discs**

All butterfly valves shall be short pattern, flanged, designed and manufactured in accordance with AWWA C504 (latest) unless otherwise specified herein or shown on the Drawings. Valve body and flanges shall be constructed of heavy duty ductile iron meeting the requirements of ASTM A536 Grade 65-45-12. Flanges shall be drilled in accordance with ANSI B16.1 standards (Class 125) and shall be of the short body design. The disc shall be 316 stainless steel and be securely attached to a 316 stainless steel shaft with stainless steel pins. Valves shall have sleeve type PTFE bearings, EPDM packing, and a resilient seat of EPDM material mounted in the valve body. Valves shall be rated for a minimum working pressure of 250 psi unless otherwise specified. Valves shall be equipped with operators as shown on the Drawings and as specified herein. Butterfly valves shall be the product of a single manufacturer which shall be DeZurik, Pratt, or equal.

Where Class 250 or Class 300 valves are specified on the Drawings, they shall be of similar construction to AWWA C504 butterfly valves specified above, but shall be furnished with Class 250 flanges.

**2.07 WAFER AND LUG BUTTERFLY VALVES (ALUMINUM-BRONZE DISCS)**

All wafer and lug butterfly valves shall be heavy-duty, resilient seated, rated 250 psi WOG and suitable for installation between ANSI Class 125/150 flanges, unless otherwise specified herein or shown on the Drawings. Valves shall be capable of bidirectional, drip tight shut off, and dead end service to 250 psi. Valve body shall be of one piece ductile iron construction including an integrally cast top plate for direct, flush-mounting actuator and shall meet ANSI Class 125/150 flange standards with valve neck of sufficient length to allow for flange clearance and piping insulation.

Resilient seat shall be reinforced EPDM, fully isolating the valve body, stem, and journal areas from the flowing media, field replaceable, with molded-in O-rings requiring no gaskets between valve and flange face(s). Stem shall be one or two piece 316 stainless steel (or better). Disc materials shall be aluminum-bronze. All wafer and lug butterfly valves shall be the product of a single manufacturer and shall be Keystone, Demco, or equal.
2.08 WAFER AND LUG BUTTERFLY VALVES (316 STAINLESS STEEL DISCS)

Unless specified otherwise, all wafer and lug butterfly valves shall be designed for installation between 125 lb. flat face or 150 lb. raised face flanges. The valve shall be non-directional and of the dry stem journal design, providing bubble-tight shut off at 200 psi differential pressure.

Valve bodies shall be gray iron or cast iron in accordance with ASTM A48 or ASTM A126. Valve bodies shall be provided with an integrally cast top plate for direct, flush-mounting of actuator, and with valve neck of sufficient length to allow for flange clearance and piping insulation. Valve stems shall be 416 stainless steel of the non-wetted two piece design with the lower stem acting as a trunnion for the valve disc and the upper stem being the drive shaft.

The valve disc shall be of a high flow design and constructed of 316 stainless steel in accordance with ASTM A351 (CF8M). The valve disc to stem engagement shall have no mechanical fasteners, allowing the valve disc to float to a perfect seal in the valve seat. The valve seat shall have a rigid phenolic backup ring with Buna-N elastomer bonded to it, rendering the valve seat suitable for pressure or vacuum service. The valve seat shall incorporate its own flange seals and they shall mate with full face or raised face flanges. The valve seat shall fully isolate the valve body, stem, and journal areas from the flowing media and shall be field replaceable.

The valve body shall incorporate O-ring secondary seals to maintain lubricant in the stem journals and eliminate exterior moisture from the stem journals.

All wafer butterfly valves shall be the product of a single manufacturer, and shall be Keystone Series 60, Demco Series NE-C, or equal.

2.09 GATE VALVES (4" THROUGH 12")

Gate valves shall be resilient seated gate valve designed and manufactured in accordance with AWWA C509 (latest) unless otherwise shown on the Drawings or specified herein. Valve shall have a non-rising bronze stem, cast ductile iron body and disc in conformance with ASTM A126, and flanges in full conformance with ANSI B16.1, Class 125. Valve disc shall be permanently bonded with resilient material to ensure drip tight shutoff. Valves shall have two stem seal O-rings of Buna N to prevent leakage through the stem. Valves shall be rated for a minimum working pressure of 200 psi unless otherwise specified. Valves shall have operators as shown on the Drawings and as specified herein. Gate valves shall be the product of a single manufacturer and shall be M&H, Stockham, Clow, Mueller, American Darling, or equal.
2.10 GATE VALVES (14" THROUGH 42")

Gate valves shall be double disc, non-rising stem type designed and manufactured in accordance with AWWA C500 (latest) unless otherwise shown on the Drawings or specified herein. Valve bodies shall be cast iron meeting the requirements of ASTM A126, Class B, with flanges conforming to ANSI B16.1, Class 125. Disc shall be cast iron, bronzed faced. Stem shall be bronze and have O-ring seals to prevent leakage through the stem. Valves shall be rated for a minimum working pressure of 150 psi unless otherwise specified. Valves shall have operators as shown on the Drawings and as specified herein. Valve shall be the product of a single manufacturer and shall be M&H, Kennedy, Clow, Mueller, or equal.

2.11 SWING CHECK VALVE (3" AND SMALLER)

Swing check valves shall be minimum 125 lb. screwed ends and bronze construction. Valves shall have a bronze disk, stainless steel or bronze pin, and have a screwed cap to access disk. Swing check valves shall be the product of a single manufacturer and shall be by Milwaukee #509, Stockham #B-319, Crane #1707, Powell #578, or equal.

2.12 SWING CHECK VALVES (3" AND LARGER)

Swing check valves shall be of the flanged body, outside lever and spring type in accordance with AWWA C508, unless otherwise specified herein or shown on the Drawings. Valves shall be fully opening, have a flanged cover piece to provide access to the disc, and be designed for minimum water-working pressure of 150 psi, unless otherwise shown. The valve body and cover shall be cast iron conforming to ASTM A126, Class B, with flanges conforming to ANSI B16.1, Class 125, unless otherwise specified. The valve disc shall be cast iron, ductile iron, or bronze conforming to ASTM B62. Valve seat and rings shall be bronze conforming to ASTM B62 or of Buna N. The hinge pin shall be of bronze or stainless steel. Valves shall be delivered to the site with the lever arm and spring adjusted for the valves installed position (vertical or horizontal). Swing check valves shall be the product of a single manufacturer and shall be APCO by Valve and Primer Corporation, Clow, Mueller, M&H, or equal.

Where Class 250 swing check valves are shown on the Drawings, they shall be similar to Class 150 swing check valves specified above, but constructed with ductile iron body and disc and Class 250 flanges. Valves shall be rated for 250 psi working pressure and be as manufactured by APCO by Valve and Primer Corporation, or equal.
2.13 SILENT CHECK VALVES

Silent check valves shall be globe-style with flanged ends, APCO Series 600, Val Matic Series 1800, Crispin Model GC, or equal. Check valves shall have a service pressure rating of not less than 300 psi and shall be provided with 250 lb flanges.

Check valve shall be of the silent operating type that begins to close as the forward flow velocity diminishes and be fully closed at zero velocity preventing flow reversal and resultant water hammer or shock. Valve design shall incorporate a center guided, spring loaded poppet, guided at opposite ends and having a short linear stroke that generates a flow area at least equal to the pipe. Operation of the valve shall not be affected by the position of installation. It shall be capable of operating in the horizontal or vertical position with the flow up or down.

All component parts shall be field replaceable without the need of special tools. A replaceable guide bushing shall be provided and held in position by the valve's spring. The spring shall be designed to withstand 100,000 cycles without failure and exert a force which allows the valve to start operating at a differential pressure of .5 psi and to fully open at a flow velocity of 4 fps.

The valve disc shall be concave to the flow direction providing for disc stabilization, maximum strength and a minimal flow velocity to fully open the valve. Valve interior shall be contoured and unrestricted to achieve maximum flow capacity with minimum pressure drop.

The valves disc and seat shall be field replaceable and have a seating surface finish of 32 micro-inch or better to insure positive seating at all pressures unless otherwise specified, a buna-n seal shall be furnished to provide zero leakage. The seal design shall provide for both a metal to metal seal and a metal to buna-n seal to achieve resilient sealing at both low and high pressures without overloading or damaging the buna-n seal.

Valves shall be hydrostatically tested at 1.5 times their rated working pressure and suitable for field testing at this pressure. Factory testing of each valve supplied shall be required for any manufacturer not specified herein.

Valve shall be provided with cast or ductile iron body, bronze plug and seat, and stainless steel spring. Contractor shall furnish connecting pipe with flat face flange, full face gaskets and a rating internal diameter as recommended by the valve manufacturer.
2.14 PLASTIC BALL VALVES

A. General

Plastic ball valves shall be constructed of polyvinylchloride (PVC), chlorinated polyvinylchloride (CPVC), polypropylene (PP), or polyvinylidene fluoride (PVDF) as specified, shown on Drawings, and recommended by the manufacturer for the service condition specified. All valves shall have manual operators, unless otherwise specified or shown. All plastic ball valves shall have true union ends for easy removal. The balls shall have full size ports and polytetrafluoroethylene (PTFE, trade name Teflon) seats, unless otherwise specified on the Drawings or by Chemical Feed System Technical Specifications. Unless specified otherwise, body seals, union O-ring seals, and stem seals shall be constructed of elastomers (Viton, EPDM, Nitrile, or Chlorinated Polyethylene). Seal and O-ring material shall be compatible with the specified chemical and shall be as selected by the manufacturer. Valves shall be the product of a single manufacturer and shall be Plast-O-Matic, Chemtrol, Asahi/American, Hayward, IPEX, or equal.

B. PVC and CPVC Ball Valves for Sodium Hypochlorite Service

Where sodium hypochlorite with a concentration greater than 1% is specified, valves shall be provided with factory-drilled vented balls (field drilling of balls to provide venting is not acceptable). Unless shown otherwise on the Drawings, valves shall be provided with socket ends.

C. PVC and CPVC Ball Valves for Chlorine Gas (Vacuum) Service

Valve body seals and O-rings shall be constructed of Viton. Valves shall be specially packaged and designated for "dry chlorine gas service", and shall be lubrication-free and factory clean room assembled. Unless shown otherwise on the Drawings, valves shall be provided with socket ends. Valves shall be as manufactured by Plast-O-Matic (no substitutes).

D. PVC and CPVC Ball Valves for Chlorine Solution Service

Valve body seals and O-rings shall be constructed of Viton. Unless shown otherwise on the Drawings, valves shall be provided with socket ends. Valves shall be as manufactured by Plast-O-Matic (no substitutes).
E. **Pneumatically Actuated Ball Valves**

Where specified, pneumatically actuated ball valves shall be provided with operators in accordance with Part 2.03D herein. Pneumatically actuated ball valves shall be equipped with a multiport single solenoid, which shall open the valve when energized and close the valve when de-energized.

F. **Electric Motor Actuated Ball Valves**

Actuators shall be 120 VAC energized to open and energized to close and provided with visual position indication; open and closed indicating lights; permanently lubricated gearing; de-clutchable manual override; space heater; overload protection; open and closed limit switches; and NEMA 4X and 6 rated enclosure. Electric motor actuators for ball valves shall be Series 17 by Asahi/American, or equal.

### 2.15 PLASTIC AIR RELEASE AND DEGASSING VALVES

A. **Air Release Valves**

Plastic air release valves for corrosives shall be made of PVC or CPVC as specified, shown on the Drawings, and recommended by the manufacturer for the service condition specified. All air release valves shall be installed vertically at high points of the piping system to vent large quantities of air during startup of the system and trace amounts of air during normal operation of the system. Air release valves shall be normally open valves that utilize a floating poppet or ball that rises and seats (valve closes) when liquid is present. The poppet or ball shall fall and unseat (valve opens) when air is present allowing the air to be released from the system. Air release valves shall be of single union (minimum) design and all seals shall be Viton.

Air release valves shall have a minimum working pressure rating of 175 psi at 110°F and shall be as manufactured by Hayward or equal.

B. **Degassing Valves**

Plastic degassing valves for corrosives shall be made of PVC or CPVC as specified, shown on Drawings, and recommended by the manufacturer for the service condition specified. All degassing valves shall be installed vertically at high points of the sodium hypochlorite piping system to continuously vent the trace amounts of gas produced. Gas shall be automatically released by a floating lever that opens when gas is present, and closes when liquid is present. All seals shall
be EPDM. Degassing valves shall be able to function properly up to 100 psi operating pressure with minimal emission of system liquid prior to sealing. The outlet port shall be piped to a U-vent in a safe area to prevent contact with the sodium hypochlorite. Degassing valves shall be the product of a single manufacturer and shall be Plast-O-Matic, or equal.

2.16 PLASTIC BALL CHECK VALVES

Plastic ball check valves shall be constructed of PVC, CPVC, or PP, as specified, shown on Drawings, and as recommended by the manufacturer for the service condition specified. Valves shall be true union type for easy removal. Unless shown otherwise on the Drawings, valves shall be provided with socket ends. Valve seats and union O-rings shall be constructed of PTFE coated Viton, or Viton. Valves shall be as manufactured by Chemtrol, Asahi/American, or equal.

2.17 FOAM SPRAY NOZZLES

A. Quick Flush Foam Control Nozzle

Foam spray nozzles shall be furnished and installed at locations shown on the Drawings. The nozzles shall be counter balanced weighted, easy flush type. The nozzle shall be bronze construction with a neoprene rubber deflector for 2 gpm at 10 psig. A split eyelet shall be utilized on all pipes smaller than 4\" in diameter. Split eyelet shall have zinc plated steel clamps and bolts with brass connector body and a Buna N clamp gasket to provide a leak proof seal. The nozzles and split eyelets shall be as manufactured by Spraying System Company, BETE Fog Nozzle, Inc., or equal.

B. Hollow Cone Foam Control Nozzle

Foam spray nozzles shall be furnished and installed at locations shown on the Drawings. Hollow cone nozzles shall produce a 90\" hollow cone spray pattern at 2 gpm at 10 psi, shall be 1/4\" NPT (M), and constructed of 316 stainless steel. Nozzle shall be as manufactured by Spraying System Company, BETE Fog Nozzle, Inc., or equal.

2.18 SEWAGE AIR RELEASE VALVES

Sewage air release valves shall have an elongated body and be designed to open while pressurized, allowing entrained air in the pipeline to escape through the air release orifice. Unless otherwise specified, each unit shall be supplied with isolation valve (solid wedge gate), blowoff valve, 1/2\" back flushing shutoff valve, and 5\' rubber supply hose
with quick disconnect couplings. The unit shall be designed for an operating pressure of not less than 125 psi. The body and cover shall be cast iron, internal float and float guide shall be stainless steel with Buna N seat, valves shall be gate type of bronze construction. Seat hardness shall be selected by the manufacturer for actual operating pressure of system. The sewage air release valve shall be manufactured by APCO by Valve and Primer Corporation, Val-Matic Valve, Multiplex Manufacturing Corporation (Crispin), or equal.

2.19 COMBINATION SEWAGE AIR AND VACUUM VALVE

Combination sewage air and vacuum valves shall have an elongated body and be of the type that automatically exhausts large quantities of air during filling of the system, allows air to re-enter during draining of the system, and allows accumulating air to escape while in operation and under pressure. Unless otherwise specified, each unit shall be supplied with isolation valve (solid wedge gate), blowoff valve, 1/2" back flushing shutoff valve, and 5' rubber supply hose with disconnect couplings. The unit shall be designed for an operating pressure of not less than 125 psi. The body and cover shall be cast iron, internal float and float guide shall be stainless steel with Buna N seat, valves shall be gate type of bronze construction. Seat hardness shall be selected by the manufacturer for actual operating pressure of the system. Combination sewage air and vacuum valves shall be manufactured by APCO by Valve and Primer Corporation, Val-Matic Valve, Multiplex Manufacturing Corporation (Crispin), or equal.

2.20 AIR VALVES

Unless specified otherwise, air valves shall be combination air or combination air and vacuum valve (air, vacuum, and automatic release). They shall permit automatic escape of large quantities of air from pipeline when it is being filled, permit air to enter pipeline when it is being emptied, and allow accumulating air to escape while pipeline is in operation and under pressure.

Air valves shall have ductile iron bodies and covers, stainless steel floats rated 1,000 psi minimum, all bronze or stainless steel internal working parts, and stainless steel pressure seats.

Air valve inlets shall be size as shown on Drawings, flanged or threaded as specified and outlets shall be threaded at the same nominal sizes as the inlets, minimum. Air valves shall be subjected to factory hydrostatic test at pressure equal to 200% rated working pressure with no harmful deflections or other defects.

Valves shall be as manufactured by APCO by Valve and Primer Corporation, Val-Matic Valve, Multiplex Manufacturing Corporation (Crispin), or equal.
2.21 WYE STRAINERS

Wye strainers shall be installed where shown on the Drawings and specified herein. Strainers shall be suitable for a minimum 150 psi working pressure unless otherwise specified. Strainers shall be cast iron with 316 stainless steel No. 40 mesh strainer screen. Wye strainers shall be manufactured by Watts, Spirax Sarco, Crane, Hayward, A.W. Cash Valve, or equal.

2.22 GLOBE VALVE (3" AND SMALLER)

Globe valves shall be 150 lb., screwed ends, bronze construction with renewable PTFE or Buna N disc. Globe valves shall have a rising stem and union bonnet. Globe valves shall be the product of a single manufacturer and shall be Milwaukee #590, Stockham #B22, Crane #7, Powell #150, or equal.

2.23 GATE VALVES (3" AND SMALLER)

Gate valves shall be 150 lb., screwed ends, bronze construction meeting the requirements of ASTM B62. Valves shall have a rising stem, gland packed, solid wedge disc, and a union bonnet. Gate valves shall be the product of a single manufacturer and shall be Milwaukee #1151, Stockham #B-120, Crane #431, Powell #2714, or equal.

2.24 SMALL PRESSURE REDUCING AND REGULATING VALVES (AIR AND WATER)

Pressure reducing and regulating valves shall be of the spring-loaded diaphragm type with a minimum pressure rating of 250 psi, with bronze body, nickel alloy or stainless steel seat, and threaded ends. Each valve shall be furnished with built-in or separate strainer and union ends. Valves shall provide pressure relief or regulation as required by the Drawings as specified. Valves shall be manufactured by A.W. Cash Valve Mfg. Corp., Fisher Controls Company, Mueller Company, Watts Regulator Company, or equal.

2.25 STAINLESS STEEL BALL VALVES

Ball valves shall be 300 lb (minimum) water working pressure, full bore, with 316 stainless steel (or better) body, ball, and stem. Ball valves shall be provided with free floating ball, reinforced PTFE (RPTFE) seats, PTFE seals, and blow-out proof stems. Ball valves 2" and smaller shall be provided with threaded ends, two-piece bodies, and stainless steel operating levers with locking device, unless flanged ends are specified on the Drawings. Ball valves 3" and larger shall be provided with flanged ends and split bodies, unless otherwise specified or shown on the Drawings. Where ball valves 3" and larger are specified or shown on the Drawings to be provided with threaded ends, said
valves shall be provided with three-piece bodies. Ball valves 3” and larger shall be provided with worm gear operator as specified herein. Ball valves shall be as manufactured by Sharpe Valves, or equal.

Where specified for gas service (natural gas or digester gas), ball valves shall be certified fire safe to API-607, and shall be furnished with anti-static devices, and shall be as manufactured by GWC Valve International, Inc., or equal.

2.26 BRONZE BALL VALVES (2-1/2" AND SMALLER)

Ball valves shall be of the size shown on the Drawings and shall be full-port type. Ball valves shall be rated for not less than 300 psi WOG. Valves shall have a bronze body and stainless steel ball and stem. Valve body shall be two-piece and shall be provided with threaded ends. Valve stems shall be of blowout-proof design with Teflon seats and stem packing, and adjustable packing gland. Valves shall be provided with vinyl sheathed stainless steel lever handles. Ball valves shall be as manufactured by Apollo, Milwaukee, or equal.

2.27 HOSE BIB ASSEMBLIES

Each hose bib assembly shall consist of a ball valve, threaded pipe nipple, and 90-degree elbow (FNPT x hose thread or FNPT x FNPT with MNPT x hose thread adaptor). Material of ball valve, elbow, and adapter for hose bib assemblies connected to brass water piping systems shall be constructed of bronze or Type 316 stainless steel. Material of ball valve, elbow, and adapter connected to stainless steel piping systems shall be constructed of Type 316 stainless steel. Ball valves, piping, and fittings shall be as specified in the Contract Documents. Ball valve shall be installed on the pipe riser below the elbow.

2.28 SOLENOID VALVES

A. Metal Solenoid Valves

Metal solenoid valves shall be of the size, type, and class shown and shall be designed for not less than 150 psi water-working pressure. Valves for water, air, or gas service shall have brass or bronze body with, unless specified otherwise, screwed ends, stainless steel trim and spring, PTFE or other resilient seals with material best suited for the temperature and fluid handled. Solenoid valves in corrosive environment shall have stainless steel bodies. General purpose enclosures for indoors shall be NEMA type 2. For explosion proof, corrosive, special purpose, or outdoor locations NEMA type 4, 7, 8, 9, 9E, 9F, or 9G
enclosures shall be used, as applicable. All coil ratings shall be for continuous
duty. For electrical characteristics see electrical drawings or specifications.

For general duty valve shall be as manufactured by Automatic Switch Co. (ASCO),
Model "RED HAT", Skinner Valve Division of Honeywell, Model "LANCER",
Magnatrol Valve Corporation, or equal.

B. Plastic Solenoid Valves

Plastic solenoid valves shall be provided as shown on the Drawings. Plastic
solenoid valves shall be constructed of PVC or CPVC (matching connection
piping) with true-union bodies, socket ends, polyester coil, 1/2" threaded
conduit port, and FPM o-ring seals. Plastic solenoid valves shall be normally
closed and 120 VAC energized to open, rated for 120 psi operating pressure at
70°F.

Plastic solenoid valves shall be SV Series by Hayward, or equal.

2.29 CAST IRON KNIFE GATE VALVES

Knife gate valves shall be bonnetless wafer type, with resilient seat and a rated pressure
of 150 psi. Gate, outside trim, bolting, stem, and yoke shall be constructed of Type 316
stainless steel. Valve body and packing gland shall be of cast iron and ductile iron with
plastic coating respectively. Resilient seat shall be HYCAR and packing shall be TFE
impregnated synthetic. Gates shall be finish-ground on both sides to prevent packing or
seat damage. Actuator shall be handwheel. Port design shall be full round. Valves shall
be manufactured by Red Valve, DeZurik, ITT Industries, or equal.

2.30 STAINLESS STEEL KNIFE GATE VALVE

Knife gate valves shall be bonnetless wafer type, constructed entirely of Type 316
stainless steel, with resilient seat and a rated pressure of 150 psi. Valve body, gate,
outside trim, packing gland, bolting, stem, and yoke shall be constructed of Type 316
stainless steel. Resilient seat shall be HYCAR and packing shall be TFE impregnated
synthetic. Gates shall be finish-ground on both sides to prevent packing or seat
damage. Actuator shall be handwheel. Port design shall be full round. Valves shall be
manufactured by Red Valve, ITT Industries, or equal.
2.31  METAL VALVES FOR SODIUM HYPOCHLORITE SOLUTION

A.  Shutoff Valves

Metal shutoff valves for sodium hypochlorite solution shall be ball valves and shall be 150 lb (minimum), full bore, with 3-piece bodies and of Hastelloy-C construction. Body and ends shall be constructed of Type CW12MW Hastelloy-C meeting the requirements of ASTM A494. Ball and stem shall be constructed of Hastelloy-C276 meeting the requirements of ASTM B574. Ball valves shall be provided with free floating ball, reinforced TFE seats, TFE seals, and blow-out proof stems. Ball valves 2" and smaller shall be provided with threaded ends and stainless steel operating levers with locking device. Ball valves 3" and larger shall be provided with flanged ends and worm gear operator as specified herein.

Unless otherwise shown on the Drawings or modified by Chemical Feed Systems Technical Specifications, metal ball valves for sodium hypochlorite solution shall be provided as specified herein.

Manufacturer shall confirm the materials specified herein are suitable for the service condition specified.

Ball valves shall be the product of a single manufacturer and shall be Series 99 as manufactured by Sharpe Valves, or approved equal.

B.  Check Valves

Metal check valves for sodium hypochlorite solution shall be ball check valves, 150 lb (minimum), and completely of Hastelloy-C construction. Body shall be constructed of Type CW12MW Hastelloy-C meeting the requirements of ASTM A494. Ball shall be constructed of Hastelloy C276 meeting the requirements of ASTM B574. Seat shall be reinforced TFE and seals shall be TFE O-rings. Ball check valves shall be provided with a bolted cover or threaded cap for accessing the ball. Ball check valves 2" and smaller shall be provided with threaded ends. Ball check valves 3" and larger shall be provided with flanged ends.

Unless otherwise shown on the Drawings or modified by Chemical Feed Systems Technical Specifications, metal ball check valves for sodium hypochlorite solution shall be provided as specified herein.

Manufacturer shall confirm the materials specified herein are suitable for the service condition specified.
Ball check valves shall be the product of a single manufacturer and shall be Series 25 as manufactured by Sharpe Valves, or approved equal.

2.32 INSULATION COVERS

Where specified or shown on the Drawings for valves, instrumentation, and various appurtenances to be insulated, insulation shall be vitreous silicate fiber thermal insulation mat with asbestos free PTFE resin impregnated woven fiberglass fabric exterior shell. The exterior shell shall be top coated with pigmented PTFE. Insulation for piping shall be per Section 15070. Insulation shall be suitable for outdoor installation in ambient temperature ranges of 0°F to 120°F, weather proof, and UV resistant. Insulation cover shall completely cover the valve, instrumentation, or appurtenances and shall be capable of preventing process water from freezing. Insulation covers shall be provided with stainless steel lacing hooks and tie wire or stainless steel buckles with Velcro straps to provide simple installation and removal. Insulation material shall be Treo as manufactured by Tritex, or approved equal, and exterior shell shall be 1650T as manufactured by Lewco Specialty Products, Inc., or approved equal. Insulation covers shall be factory pre-fabricated covers and shall be as manufactured by Insultech, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

All valves shall be installed in accordance with the manufacturer's recommendation, the Construction Drawings, Standard Drawings, and Contract Specifications. Valves shall be kept clean and free from dirt, earth, debris, and other deleterious materials prior to, during, and after installation and construction.

A. Buried Valves

Buried valves shall be firmly supported in place by compacted backfill to preclude strain on the pipe connections. Valve boxes shall be checked for centering plumb over the wrench nut and ensure that the box cover is flush with the finish grade. Interior of valve box shall be cleaned of all foreign material before installation. The valve shall be inspected in the opened and closed positions to ensure all parts are in working condition. Valve shall be installed in accordance with the Standard Drawings.

Unless otherwise specified, flange bolts shall be standard hex head machine per ASTM A325. Nuts shall be heavy hex cold-press semi-finished steel per
ASTM A194-2, 2H. Threads shall be lubricated with an approved anti-seize compound. All exposed steel shall be field coated with an approved bitumastic.

B. Aboveground Valves

Aboveground valves shall be rigidly held in place using supports and hangers. The stem orientation shall provide ease of operation, clearance, and be approved by the Owner.

Unless otherwise specified, flange bolts shall be standard hex head machine per ASTM A325. Nuts shall be heavy hex cold-press semi-finished steel per ASTM A194-2, 2H. Threads shall be lubricated with an approved anti-seize compound.

C. Air Valves (Potable and Sewage Service)

Until placed in operation, each valve shall be protected by the use of an approved canvas or plastic bag or sack completely covering the valve and securely fastened to valve riser.

Air valve outlets, including combination air and vacuum valve outlets/inlets, shall be adequately screened to prevent entrance of foreign substances or materials. Where valves contain more than a single outlet, each outlet shall be adequately screened. Screens shall be installed in accordance with the Standard Drawings.

Where Standard Drawings have not been provided for air valve installation, each air valve outlet shall be equipped with standard weight pipe nipples, 90° street elbows (two total) of the same size as the outlet, and a screen. Each screen shall be constructed of 22 gauge stainless steel wire cloth banded with 1/2" wide stainless steel bands to a 10 gauge expanded stainless steel mesh cylinder (3/4" opening). The expanded stainless steel mesh cylinder shall be a minimum of 4" diameter and 5" long, tack welded to 10 gauge stainless steel round plates at each end. Unless specified otherwise, the standard weight pipe nipples and 90° street elbows shall be hot dipped galvanized.

3.02 INSULATION COVERS

Contractor shall field measure all valves and appurtenances required to be insulated prior to manufacturer constructing insulation covers. Manufacturer shall provide instruction to Contractor if field altering of insulation covers is required.

END OF SECTION
## SPECIFICATIONS - DETAILED PROVISIONS
Section 16010 - General Electrical Requirements

### CONTENTS

<table>
<thead>
<tr>
<th>PART 1 - GENERAL</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.01 DESCRIPTION</td>
<td>1</td>
</tr>
<tr>
<td>1.02 QUALITY ASSURANCE</td>
<td>1</td>
</tr>
<tr>
<td>1.03 UTILITY COMPANY REQUIREMENTS</td>
<td>5</td>
</tr>
<tr>
<td>1.04 SUBMITTALS</td>
<td>6</td>
</tr>
<tr>
<td>1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING</td>
<td>10</td>
</tr>
<tr>
<td>1.06 COORDINATION OF WORK AND TRADES</td>
<td>11</td>
</tr>
<tr>
<td>1.07 COORDINATION OF THE ELECTRICAL SYSTEM</td>
<td>12</td>
</tr>
<tr>
<td>1.08 RELATED WORK SPECIFIED ELSEWHERE</td>
<td>12</td>
</tr>
<tr>
<td>1.09 PERMITS</td>
<td>13</td>
</tr>
<tr>
<td>1.10 OUTAGES</td>
<td>13</td>
</tr>
<tr>
<td>1.11 AREA CLASSIFICATION DESIGNATIONS</td>
<td>13</td>
</tr>
<tr>
<td>1.12 WARNING SIGNS</td>
<td>14</td>
</tr>
<tr>
<td>1.13 GUARANTEE AND WARRANTY</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PART 2 - PRODUCTS</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.01 MATERIALS AND EQUIPMENT</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PART 3 - EXECUTION</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.01 GENERAL</td>
<td>16</td>
</tr>
<tr>
<td>3.02 ELECTRICAL SUPERVISION</td>
<td>16</td>
</tr>
<tr>
<td>3.03 INSPECTION</td>
<td>16</td>
</tr>
<tr>
<td>3.04 PREPARATION</td>
<td>17</td>
</tr>
<tr>
<td>3.05 WORKMANSHIP</td>
<td>17</td>
</tr>
<tr>
<td>3.06 PROTECTIVE DEVICE ADJUSTMENTS</td>
<td>17</td>
</tr>
<tr>
<td>3.07 JOB SITE CONDITIONS AND ELECTRICAL DRAWINGS</td>
<td>17</td>
</tr>
<tr>
<td>3.08 FIELD TESTING AND QUALITY CONTROL</td>
<td>19</td>
</tr>
</tbody>
</table>
PART 1 - GENERAL

1.01 DESCRIPTION

Contractor shall provide all the materials and equipment, and perform all work necessary for the complete execution of the electrical work as indicated on the Drawings, as specified herein, and as specified in other Specification Sections. Miscellaneous appurtenances are not necessarily specified or indicated on the Drawings. Contractor shall provide all labor and materials not specifically indicated on the Drawings or specified in these Specifications, yet required to ensure proper and complete operation of all systems.

This Section summarizes the general requirements for electrical work, and forms a part of all other Sections of these Specifications, unless otherwise specified.

1.02 QUALITY ASSURANCE

A. General

1. It is the intent of these Specifications and the Drawings, to secure highest quality in all equipment and materials, and to require first-class workmanship, in order to facilitate trouble free operation and minimum maintenance of the electrical system.

2. All work, including installation, connection, calibration, testing and adjustment, shall be performed by qualified, experienced personnel who are technically skilled in their trades, are thoroughly instructed, and are competently supervised by a certified electrician in the state of California. The resulting complete installation shall reflect professional quality work, employing industrial standards and methods. Any and all defective material or inferior workmanship shall be corrected immediately to the satisfaction of the District and at no additional cost to the District.

3. All equipment and materials shall be new, listed by UL and bearing the UL label, unless exception to this requirement is inherent to an individual item specified herein, or exception is otherwise specified, or approved by the District.
4. Equipment and materials shall be the products of reputable, experienced manufacturers. Singular items in the project shall be the products of the same manufacturer. All equipment and materials shall be of industrial grade and heavy duty construction, shall be of sturdy design and manufacture, and shall be capable of long, reliable, trouble-free service.

5. Contractor shall furnish manufacturer’s electrical equipment of the types and sizes specified which has successfully operated for not less than the past two years, except where specific types are named by manufacturer and catalog number or designation under other Sections of the Contract Documents.

B. Environmental Sustainability

1. All electrical equipment and their enclosures shall be suitable for operation in the ambient conditions and area classification designations associated with the locations designated in the Contract Documents.

2. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, when the ambient temperature of the air is 50°C. Unless specified otherwise or indicated otherwise on the Drawings, heating and cooling devices shall be provided in order to maintain all electrical equipment and instrumentation devices to within a range equal to 20 percent above the minimum and 20 percent below the maximum of the rated environmental operating ranges. All power wiring and temperature controls for these devices shall be provided by the Contactor.

C. Factory Tests

Factory tests are required for all electrical equipment and assemblies applicable to the specific project. Perform factory tests in accordance with the requirements of the particular equipment specification sections and in accordance with the codes and standards specified as applicable to the equipment. Items to be factory tested shall include, but not be limited to:

1. Motor Control Centers

2. Electrical Service Switchboards and Distribution Switchboards

3. Variable Frequency Drives

4. Solid State Starters

5. Automatic Transfer Switches
6. Manual Transfer Switches

7. Induction Motors

8. Emergency Generators

9. Custom Control Panels

10. Programmable Logic Controllers

11. Instrumentation and Controls

D. Codes and Standards

Provide electrical equipment and materials, including installation, conforming to the following codes and standards, as applicable. The equipment and materials shall bear labels to indicate manufacturing conformance to the specified standards, or equal.

1. American National Standards Institute (ANSI)

2. California Energy Commission (CEC), Title 24

3. Institute of Electrical and Electronic Engineers (IEEE)

4. National Electrical Manufacturers Association (NEMA)

5. Underwriters' Laboratories (UL)


7. Factory Mutual (FM)

8. Insulated Power Cable Engineers Association (IPCEA)


10. NFPA 70 - National Electrical Code (NEC)


12. Occupational Safety and Health Regulations of Occupational Safety and Health Administration (OSHA)
13. City and State Electrical Codes. Applicable portions of local and state codes.

14. Serving Utility Company (service, metering and interconnection requirements)

15. South Coast Air Quality Management District (SCAQMD)

16. National Institute of Standards and Technology (NIST)

17. National Electric Testing Association (NETA)


19. Certified Ballast Manufacturers Standards

20. Illuminating Engineering Society Handbook Standards

21. Basic Electrical Regulations, Title 24, State Building Standards, California Administrative Code

22. Low Voltage Electrical Safety Orders, Title 8, Division of Industrial Safety, State of California

Underwriters' Laboratories Approval: All equipment furnished by the Contractor shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated (UL), or Edison Testing Labs (ETL), or of a Nationally Recognized Testing Laboratory (NRTL) acceptable to the District.

Where the Drawings or these Specifications call for equipment and workmanship to be of better quality of higher standard than required by the above codes, standards, rules, and regulation, then said Drawings and Specifications shall prevail. Nothing on the Drawings or in these Specifications shall be construed to permit work in violation of the above codes, standards, rules, and regulations and the Contractor shall be held responsible for any work which is not acceptable.

In case of conflict or disagreement between building codes, state law, local ordinances, industry standards, utility company regulations, Drawings and Specifications, or within the Contract Document itself, the most stringent condition shall govern. The Contractor shall promptly notify the District in writing of such differences.
1.03 UTILITY COMPANY REQUIREMENTS

A. Unless specified otherwise, the District will make application for electric and telephone service (if applicable). The District will pay utility company connection fees for permanent service. Fees for temporary service during construction shall be paid by the Contractor.

B. All work for electrical power shall be performed in accordance with the requirements of the respective serving utility companies.

C. Immediately after the award of the contract, the Contractor shall notify the serving utilities that the project is under construction and provide them with all pertinent information, including the dates on which the services will be required.

D. Shop drawings shall be submitted to the power utility company with the appropriate panel dimensions (top view and elevation view) and EUSERC (Electric Utilities Service Equipment Requirement Committee) No. for service entrance and metering sections (electrical service switchboard), unless indicated otherwise on the Drawings. The power utility company serving the District is Southern California Edison (SCE).

E. Contractor shall coordinate details and timing of service switchboard installation with SCE, provide all required temporary service, and include all utility connection fees for temporary service in his bid proposal. In addition, all coordination and fees associated with obtaining from SCE the maximum available short circuit current at the secondary side of the service transformer shall be obtained by the Contractor.

The District will “Green Tag” the service when all SCE requirements and NEC grounding requirements are met. Contractor shall provide the services of an independent testing consultant for all testing required to Green Tag the service, as specified herein and in Section 16040.

F. Where indicated on the Drawings, the Contractor shall construct new electrical services per SCE requirements, the SCE Service Plan, and in accordance with the Contract Documents. Contractor shall furnish and install all facilities as required by the SCE Service Plan and as indicated on the Drawings. Facilities may include conduits, intercept box, transformer pad, slab box, service switchboard, and associated appurtenances. SCE will furnish and install the service transformer and conductors from utility power location to transformer, and from transformer to service meter. Copies of the SCE Service Plan (if available) are attached in Special Conditions or in an Appendix to these Specifications.

G. Contractor shall install telephone service entrance conduit, backboard, receptacles, grounding, and other telephone equipment indicated on the Drawings in accordance with the serving utility's requirements.
1.04 SUBMITTALS

A. General

Contractor shall provide submittals (shop drawings) in accordance with the requirements of the District’s General Conditions, and as specified herein and in other Sections of Division 16. Shop drawings shall be submitted for the following items:

1. All electrical equipment and materials including conduit, conductors, pull boxes, junction boxes, and appurtenances.

2. Switchboards, panelboards, motor control centers, variable frequency drives, terminal cabinets, transformers, and other major equipment or apparatus.

3. Control panels and other specially-fabricated or custom-made equipment.

4. Other items as may be specifically called for herein or per other Sections of the Specifications.

B. Shop Drawings

1. Submit a complete list of all materials, equipment, apparatus, and fixtures; including manufacturer’s product literature and data; clearly indicating which equipment, materials, accessories, etc. the Contractor proposes to use. The list shall include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

2. Contractor shall submit detailed dimensioned shop drawings of all designated equipment for District's review before fabrication. Drawings submitted for review shall include front views, top and bottom views, internal elevation views, sections, and anchoring details. Separate drawings shall be submitted for control and wiring diagrams. Wiring diagrams shall be provided for all electrical equipment furnished, except lighting. Shop drawings shall be checked by the Contractor before submittal for review by the District, and the Contractor shall certify that the submittals are in accordance with the Drawings and Specifications. Should an error be found in a shop drawing during installation of equipment, the correction, including any field changes found necessary, shall be noted on the drawings, and the as-built drawings shall be provided with the final equipment operation and maintenance manuals.
3. Manufacturer catalog literature, bulletins, brochures or the like shall be submitted for all materials and equipment. This data shall be submitted together with a clear indication (arrows) of the specific item or items, or class of items proposed, in order to establish written record of the Contractor’s intent. A list of items indicating "as specified" will not suffice. A manufacturer's name alone will not suffice. Each sheet of descriptive literature submitted shall be clearly marked by the Contractor to identify the material or equipment as follows:

a. Lamp fixture descriptive sheets shall show the fixture schedule type for which the sheet applies.

b. Equipment and materials descriptive literature and drawings shall indicate the Specification Section and Subsection for which the equipment and/or materials applies.

c. Sheets or drawings showing more than the particular item under consideration shall have crossed out all but the pertinent description of the item for which review is requested.

d. Equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications shall be identified by a suitable notation.

e. Schematic, wiring, and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections. Connection diagrams shall indicate field installed equipment with the specified drawing device number or name as illustrated on the Construction Drawings and submitted shop drawings.

4. Submit data for earthquake (seismic) design and restraint with the shop drawing submittals for all switchboards, panelboards, motor control centers, variable frequency drives, and control panels. Anchorage data and details shall be provided for same. Calculations and details shall be stamped by a California registered "Civil" or "Structural Engineer." Refer to Special Conditions and Section 11005 for special seismic design requirements.
C. As-Built Drawings

Contractor shall prepare, maintain, and submit as-built Drawings in accordance with the District’s General Conditions, and as specified herein.

At the completion of the Work, Contractor shall furnish the District with three (3) final sets of as-built electrical Drawings marked with any changes, deviations or additions to any part of the electrical work. During construction, one (1) red-lined set of as-built Drawings shall be maintained at the job site by the Contractor until the final as-built Drawings are received by the District.

Contractor shall clearly indicate on the as-built Drawings the following information:

1. All conduit runs as actually installed.
2. Location of all underground conduits and stub-outs accurately dimensioned.
3. Forming, cabling, and identification of all power and control conduit and wiring within manholes, pull boxes, junction boxes, and terminal boxes.
4. Interior views of each manhole and pull box identifying each conduit entrance by conduit number.
5. All changes, deviations, or additions to any part of the electrical work, including, but not limited to: locations, routing, dimensions, wiring, or connections.

D. Operation and Maintenance Manuals

Contractor shall provide operation and maintenance (O&M) manuals for all electrical equipment in accordance with District’s General Conditions, Section 01430, and as specified herein.

The manuals shall include all system drawings, block diagrams, single line and control diagrams, wiring schematics, loop diagrams, shop drawings, manufacturer product literature and data for supplied equipment and other pertinent data required to completely describe the operation and maintenance of the installed electrical system.

These manuals shall be submitted prior to final acceptance of the system and shall reflect all as-built conditions.
As a minimum, the electrical system information in the O&M manuals shall contain:

1. System operating instructions written for the benefit of the District's operating personnel for normal operational condition and utilizing names of controls as they appear on nameplates.

2. Installation instructions.

3. Pre-energizing, energizing, and de-energizing procedures.


5. Troubleshooting instructions.


7. Instructions for ordering replacement parts.

8. Part List
   a. List of fuses, lamps, and other expendable equipment and devices with manufacturer names and part numbers.
   b. List of all vendors, addresses, and phone numbers.

E. Miscellaneous Reports

Contractor shall submit all other reports as called for in these Specifications at the times specified. These miscellaneous reports include, but are not limited to, test procedures, records of electrical test results, and manufacturer certificates of inspection.

F. Manufacturer's Certified Reports

Each equipment manufacturer, or his authorized representative, shall submit a written report with respect to his equipment certifying the following:

1. Pre-Startup Complete
   a. The equipment has been properly installed, wired, and connected in accordance with the manufacturer's requirements.
   b. The equipment is in accurate alignment.
c. Manufacturer has checked, inspected, and adjusted the equipment as necessary.

2. Startup and Field Testing Complete

a. Manufacturer was present when the equipment was placed into operation.

b. The equipment has been operated under full load conditions and operated satisfactorily.

c. All field testing, including operational demonstration and system validation testing, has been completed and equipment performed satisfactorily throughout each test.

d. The equipment is fully covered under the terms of the guarantee.


In accordance with Section 16040, Contractor shall submit electrical short-circuit/coordination study, arc-flash hazard study, and testing report certifying proper setting of all protection devices, ground testing, and arc-flash hazard labeling.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery

Contractor shall require that all electrical materials and equipment be shipped and delivered in accordance with the manufacturer’s requirements. Deliver electrical materials and equipment in manufacturer's original cartons or containers with seals intact, as applicable. Unless specified otherwise, deliver conductors in sealed cartons or on sealed reels, ends of reeled conductors factory sealed. Deliver large multicomponent assemblies in sections that facilitate field handling and installation.

B. Handling

Contractor shall unload and handle materials and equipment in accordance with manufacturer's recommendations. Lift large or heavy items only at the points designated by the manufacturer. Use padded slings and hooks for lifting as necessary to prevent damage.
C. **Storage**

Store electrical equipment and material in accordance with the manufacturer’s requirements. Where enclosures are specified to be provided with space heaters, Contractor shall furnish temporary power to equipment space heaters to prevent condensation until the equipment is installed and energized.

Unless designed for outdoor exposure, store electrical materials off the ground and under cover to prevent corrosion, contamination, or deterioration.

### 1.06 COORDINATION OF WORK AND TRADES

A. Electrical work shall conform to the construction schedule and progress of other trades. The electrical construction shall be performed in cooperation with all other trades so that a neat and orderly arrangement of the work as a whole shall be obtained.

B. Electrical components on all equipment shall be handled, set in place, connected, checked out, serviced, and placed in readiness for proper operation to the satisfaction of the District all within the scope of work intended under this Section.

C. Before any work is commenced, Contractor shall verify with the equipment manufacturers that equipment dimensions and arrangements will allow for equipment installation in the spaces provided for on the Drawings, including, but not limited to: all switchboards motor control centers, variable frequency drives, panelboards, control panels, terminal cabinets, transformers, and other items of electrical equipment or apparatus; and that the installation spaces indicated will provide for all required ventilation, clearances, access, and work space.

D. Before installing any equipment, conduit, or materials, the Contractor shall examine the complete set of Contract Documents (Drawings and Specifications) and approved shop drawings, and confirm all dimensions and space requirements.
1.07  **COORDINATION OF THE ELECTRICAL SYSTEM**

A. Contractor shall verify all actual equipment and motor full-load and locked rotor current ratings. The necessary minimum equipment, conductors, and conduit sizes are indicated on the Drawings. If the Contractor furnishes equipment of different ratings, the Contractor shall coordinate the actual current rating of equipment furnished with the branch circuit conductor size, the controller size, the motor starter, and the branch circuit over current protection. The branch circuit conductors shall have a carrying capacity of not less than 125% of the actual full-load current rating. The size of the branch circuit conductors shall be such that the voltage drop from the overcurrent protection devices up to the equipment shall not be greater than 2% when the equipment is running at full load and rated voltage. Conductor ampacities shall be derated in accordance with NEC, Table 310-16 for ambient temperatures of 114-122°F.

B. Unless specified otherwise, the motor running solid state overcurrent protection devices shall be ambient temperature compensated for 50°C and be rated or selected to trip at no more than 125% of the motor full-load current rating for motors marked to have a Class B temperature rise not over 80°C or motors marked with a service factor not less than 1.15, and at no more than 115% for all other types of motors.

C. Unless specified otherwise, the motor branch circuit overcurrent protection device shall trip open in 10 seconds or less on locked-rotor current of the motor. This device shall also protect the motor branch circuit conductors and the motor control apparatus against overcurrent due to short circuits or ground faults. The motor control circuits shall have overcurrent protection of the type specified in the Specifications, or indicated on the Drawings.

1.08  **RELATED WORK SPECIFIED ELSEWHERE**

A. The Contract Documents are a single integrated document, and as such all Specification Divisions and Sections apply. It is the responsibility of the Contractor and its Subcontractors to review all sections to ensure a complete and coordinated project.

B. Related Specification Sections include, but are not limited to, the following:

1. Sections of the Specifications specifying equipment and/or systems requiring electrical power and/or control.

2. Division 16 – Electrical

3. Division 17 – Instrumentation and Controls
1.09 PERMITS

Contractor shall obtain and pay for all permits, licenses, and inspections required for electrical construction work by public agencies and utility companies having jurisdiction, except as otherwise specified.

1.10 OUTAGES

A. Contractor shall keep equipment system power outage periods to the minimum time feasible, and only for such times and durations as may be approved by the District. Contractor shall submit any request for an equipment system power outage (shutdown) in writing to District for approval at least 10 working days in advance of said shutdown. The written request shall include the date, time, location, affected equipment and systems, and proposed duration of the shutdown. Contractor shall bear all overtime costs for outages required to be performed during non-working hours.

B. Contractor shall keep facility power outage periods to the minimum time feasible, and only for such times and durations as may be approved by the District and SCE. Contractor shall submit request for a facility power outage (shutdown) in writing to District for approval at least 45 working days in advance of said shutdown. The written request shall include the date, time, location, and proposed duration of the shutdown. If the proposed facility shutdown is approved by the District, Contractor shall provide all necessary coordination with SCE and the District throughout the planning and shutdown period. Contractor shall bear all overtime costs for facility outage required to be performed during non-working hours.

1.11 AREA CLASSIFICATION DESIGNATIONS

A. General

For purposes of defining electrical enclosure and electrical installation requirements, certain areas have been classified in this Section, other Specification Sections, or indicated on the Drawings. Electrical equipment, materials, and installations within these areas shall conform to the equipment standards and code requirements for the areas involved.

B. Indoor Locations

Unless specified otherwise, electrical work installed in indoor, dry, non-corrosive areas that are not subject to wash down and not specifically classified shall be general purpose locations. Enclosures for instruments, control panels, controllers, terminal cabinets, junction boxes, devices, etc., in general purpose locations shall be rated NEMA 12. Enclosures for motor control centers, switchboards, panelboards, and variable frequency drives in general purpose locations shall be rated NEMA 1A (gasketed).
C. **Outdoor Locations**

Unless specified otherwise, electrical work installed in indoor areas subject to wash down or installed in outdoor areas shall be classified as wet locations. Enclosures for instruments, control panels, controllers, terminal cabinets, junction boxes, devices, etc., in wet locations shall be rated NEMA 4X. Enclosures for motor control centers, switchboards, panelboards, and variable frequency drives in wet locations shall be rated NEMA 3R (weatherproof). Wherever possible, outdoor enclosures shall be gasketed, and shall be provided with hinged and padlockable doors.

D. **Corrosive Locations**

Unless specified otherwise, electrical work installed in indoor or outdoor areas with exposure or potential exposure to chemical liquids, chemical gases, sewage, or sludge shall be classified as corrosive locations. Enclosures for instruments, control panels, controllers, terminal cabinets, junction boxes, devices, etc., in corrosive locations shall be rated NEMA 4X. Wherever possible, NEMA 4X enclosures shall be constructed of Type 316 stainless steel, and shall be provided with hinged and padlockable doors.

E. **Hazardous Locations**

Unless specified otherwise, electrical work installed in indoor or outdoor areas with exposure or potential exposure to flammable gases or vapors, or combustible dusts shall be classified as hazardous locations. Enclosures for instruments, control panels, controllers, terminal cabinets, junction boxes, devices, etc., in hazardous (classified) locations shall be provided in accordance with NEC Articles 500 through 504.

### 1.12 WARNING SIGNS

A. Unless specified otherwise, permanent warning and caution signs shall be mounted at the site and on all mechanical equipment which may be started automatically or from remote locations for personnel safety. Signs shall be fabricated in accordance with Porcelain Enamel Institute Specification S-103 and shall be suitable for exterior use. Mounting details shall be in accordance with the manufacturer's recommendations. Signs shall be located as approved by District. Provide a minimum of one (1) sign at each equipment location.

B. Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18 gauge vitreous enameling stock. Sign shall read:

```
CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL
```
C. Where specified, provide a minimum of one (1) sign mounted on the entrance door of generator, blower, or compressor rooms. Sign shall read:

CAUTION
HEARING PROTECTION
SHALL BE WORN IN THE AREA

D. Permanent and conspicuous warning signs shall be mounted on all equipment and doorways to equipment rooms where the voltage exceeds 600 volts.

E. Where specified, provide a minimum of one (1) sign mounted on the door of pump or electrical rooms. Warning signs shall be 7 inches high by 10 inches wide, colored red and white, on not less than 18 gauge vitreous enameling stock. Sign shall read:

WARNING
HIGH VOLTAGE
AUTHORIZED PERSONNEL ONLY

1.13 GUARANTEE AND WARRANTY

Contractor shall guarantee all work of Division 16 in accordance with the General Conditions. With respect to equipment, guarantee shall cover (1) faulty or inadequate design; (2) improper assembly or erection; (3) defective workmanship or materials; and (4) incorrect or inadequate operation, or other failure. For equipment bearing a manufacturer's warranty in excess of one (1) year, furnish a copy of the warranty to the District, who shall be named as beneficiary.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Contractor shall provide new materials and equipment as required to complete all indicated and specified electrical work, including incidental items inferable from the Contract Documents that are necessary to complete the work. Provide materials and equipment of latest design, standard products of established manufacturers. Custom products shall be provided where required to comply with specified performance requirements or special features and capabilities.

For uniformity, only one manufacturer is acceptable for each type of product. Manufacture individual parts to standard sizes and gages so repair parts can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not be placed in service at any time prior to delivery, except as required for factory or shop tests.
A. Prohibited Materials

Aluminum conductors are not acceptable.

B. Damaged Products

Notify the District in writing if any equipment or material is damaged. Do not repair damaged products without prior written approval.

C. Factory Finishes

Unless specified otherwise in other Division 16 Sections or in the Special Conditions, the sheet metal surfaces of equipment enclosures shall be phosphatized and coated with a rust resisting primer. Over the primer, apply a corrosion resistant baked enamel finish on the interior and exterior metal surfaces. The exterior color shall be ANSI No. 49 medium light gray. The interior color shall be white. Hardware shall have a corrosion resistant finish. Sheet metal enclosures and lighting fixtures, in corrosive areas, shall have an outer coating of corrosion resistant epoxy.

PART 3 - EXECUTION

3.01 GENERAL

Contractor shall install electrical work in accordance with the codes and standards specified, except where more stringent requirements are indicated or specified. Prior to commencing construction, Contractor shall verify that equipment and materials properly fit the installation space with clearances conforming to the codes and standards specified, except where greater clearance is indicated. Contractor shall perform work as required to correct improper installations, at no additional cost to the District.

3.02 ELECTRICAL SUPERVISION

In addition to supervision required under the General Conditions, Contractor shall assign a competent representative to supervise the electrical construction work from beginning to completion and final acceptance.

3.03 INSPECTION

Contractor shall inspect each item of equipment and material for damage, defects, completeness, and correct operation before installing. In addition, Contractor shall inspect previously installed related work and verify that it is ready for installation of electrical work.
3.04 PREPARATION

Prior to installing electrical work, Contractor shall ensure that installation areas are free of debris and clean. Contractor shall maintain the areas in a broom-clean condition during installation operations. Contractor shall clean, condition, and service equipment in accordance with the manufacturer's instructions, approved submittals, and other requirements indicated or specified.

3.05 WORKMANSHIP

Contractor shall employ skilled craftsmen experienced in installation of the types of electrical equipment and materials specified. Contractor shall use specialized installation tools and equipment as applicable. Contractor shall construct acceptable installations free of defects. Refer to Part 1.02 herein.

3.06 PROTECTIVE DEVICE ADJUSTMENTS

Contractor shall adjust all protective devices in accordance with tabulated settings listed in the approved coordination study per Section 16040. In addition, adjustments shall conform to SCE requirements and IEEE Standard 242. No equipment shall be operated prior to said adjustments being properly completed and field verified/tested.

3.07 JOB SITE CONDITIONS AND ELECTRICAL DRAWINGS

A. Job Site Conditions and Drawings

1. The Drawings indicate diagrammatically the desired location and arrangement of outlets, conduit runs, equipment, and other items. Exact locations shall be determined in the field based on the physical size and arrangement of equipment, finished elevations, and obstructions. Locations indicated on the Drawings, however, shall be adhered to as closely as possible.

2. All equipment and conduit shall be installed in such a manner as to avoid all obstructions, preserving headroom, and keeping openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms as indicated on the Drawings. Where these Drawings do not indicate exact locations, Contractor shall propose locations to the District for final approval by District prior to installation. Where equipment is installed without approval and must be moved (as determined by the District), it shall be moved without additional cost to the District.
General Electrical Requirements  
Section 16010 – 18

3. Allowance has been made in the design for the number of conduits, conductors and cables, which the District considers adequate for feeding various equipment and drives. These circuits and diagrams are based on available data pertaining to a particular design of equipment and portray the systems which the District has chosen to effect the required operation and level of control. Equipment provided by the Contractor (even though of the make and model specified) may differ in detail, arrangement, connections or form from that indicated on the Drawings. If the Contractor uses equipment which differs from the equipment shown in major aspects and requires modifications to power, control or other electrical systems (including, but not limited to, size and quantity changes to conductors, conduits, starters, circuit breakers, control devices, etc.), the District's acceptance of the equipment will be based upon the Contractor providing the modification required, and they shall be of the same quality as shown and shall be provided at no additional costs to the District.

4. The Drawings do not, and are not intended to, show all required equipment, such as pull boxes, junction boxes, etc. nor to indicate all mechanical or structural difficulties that may be encountered which would necessitate routing alteration, or fittings. Items not specifically mentioned in these Specifications or noted on the Drawings or approved shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

5. Discrepancies shown on different Drawings, between Drawings and actual field conditions, or between Drawings and Specifications shall be promptly brought to the attention of the District for direction.

6. The equipment alignment and conduit shall be varied due to architectural changes, or to avoid work of other trades, without extra expense to the District.

B. Protection of Existing and New Facilities

1. Contractor shall hand dig or otherwise cautiously dig the trenches for the underground lines in areas where interferences are possible or where electric lines must pass or cross below or above existing facilities.
2. Contractor shall protect electrical equipment and materials until final acceptance by the District. Contractor shall protect factory painted surfaces from impact, abrasion, discoloration, and other damage. Contractor shall keep electrical equipment, materials, and insulation dry at all times. Contractor shall maintain heaters in equipment connected and operating until equipment is placed in operation. If partial dismantling of equipment is required for installation, box or wrap the removed parts until reinstalled. Contractor shall repair or replace damaged work as directed by the District, and at no additional cost to the District.

3.08 FIELD TESTING AND QUALITY CONTROL

A. General

1. Prior to testing equipment including wiring and cables, the equipment shall be installed and anchored in accordance with the manufacturer's recommendations and the Contract Documents. A minimum of ten (10) working days in advance of testing, Contractor shall provide written notice to the District for installation inspection. District's and equipment manufacturer's acceptance of installation shall be obtained prior to the commencement of any testing.

   a. The District intends to observe all testing, thus, the Contractor shall prepare a testing schedule showing daily work and projecting same for a minimum of three (3) weeks. Contractor shall maintain a current testing schedule and submit updated schedules to the District on weekly intervals.

   b. Contractor shall provide a minimum of ten (10) working days advance notice to the District for the scheduling of any testing.

   c. Contractor shall provide the manufacturers' documentation for testing for all equipment.

   d. In the event a retest is required due to equipment failure, adverse testing conditions, or installation deficiency, Contractor shall schedule the retest. Any impact to project schedule or testing schedule shall be borne by the Contractor.

2. Inspection and test records shall be submitted to the District no later than thirty (30) days after completion of the individual test and prior to energizing of equipment.

3. All tests shall be performed with the equipment or material de-energized, except where otherwise specifically required by the nature of the test.
4. All items not in conformance with the requirements of these Specifications shall be corrected by the Contractor.

5. Upon completion of various phases of the project, electrical equipment and wiring and cabling systems shall be inspected and tested in accordance with this Specification. All testing shall be in accordance with the applicable ANSI, IEEE, NETA, NEMA, or other national standard, and in accordance with the specific manufacturer's instruction bulletins or other literature supplied with the equipment to be tested, and the test equipment manufacturer's operating instructions. All tests that are required to be performed, whether performed by the Contractor or by the Testing Consultant (refer to Part 3.08E herein) shall be in accordance with NETA Standard for Acceptance Testing Specifications.

6. No equipment shall be energized until the testing and setting of protective devices per Section 16040 and testing as specified herein has been completed and accepted by the District.

7. Contractor shall provide all test data in tabulated form as approved by the District. Insulation testing (high potential testing) and continuity testing data shall include conductor number, size, test value, and expected value for each conductor.

8. Contractor shall check all equipment for proper mechanical adjustment and freedom of operation. All electrical equipment, both pre-wired and field-wired shall be field-tested for functional operation, including all intended modes and sequences of operation. This shall include switches, relays, non-adjustable circuit breakers, contractors, etc., including control interlock and sequence circuits. All necessary adjustments shall be made on apparatus in accordance with the manufacturer's instructions and design requirements. Alarm systems and circuits shall be tested by manually operating initiating devices. Relays and control components that may prove to be functioning incorrectly or otherwise appear to be unreliable shall be repaired or replaced as necessary. An electrical system will not be accepted until it is tested in its entirety and the results reported to and accepted by the District.
9. Each equipment manufacturer shall furnish the services of an authorized representative especially trained and experienced in the installation of his equipment to: (1) supervise the equipment installation in accordance with the Contract Documents, approved submittals, and manufacturer's instructions; (2) inspect, check, adjust as necessary, and approve the installation prior to start up; (3) submit certification that equipment is ready to start-up and test; (4) be present when the equipment is placed into operation and tested; (5) repeat the inspection, checking, adjusting, and testing until all trouble or defects are corrected and the equipment installation and operation are acceptable; and (6) prepare and submit the specified Manufacturer's Certified Report (refer to Part 1.04F herein). Contractor shall include all costs for manufacturer representatives' services in the Contract Price.

10. All costs associated with equipment and material testing and retesting (if required) shall be paid by the Contractor.

B. Testing Power, Control, and Lighting Circuits - 600 V and Below

Contractor shall perform continuity checks of all power, control and lighting conductors and cables, including each conductor of multi-conductor and multi-pair cables. Continuity checks shall be performed prior to termination of conductors and cables, and any testing by the Testing Consultant.

1. Contractor shall visually check all conductor and cable connections, verify conductor numbers, and verify that the actual wiring conforms to the Drawings and shop drawings.

2. Each power conductor shall be tested to ensure proper phase identification.

3. The conductor ends shall be cleaned and guarded for personnel safety during testing. Circuits in the immediate vicinity that are not under test shall be grounded.

4. Contractor shall perform insulation resistance tests on all 600 V rated power conductors. Each conductor shall be tested against ground with the conduit and/or all other conductors connected to ground. Motor feeder circuits shall be tested with motors disconnected and the controller open. Lighting panelboard main feeder circuits, including lighting panelboard and transformer, shall be tested with the branch circuit breakers open. Testing shall be for one minute using 1000 V DC. Values of insulation resistance less than 50 megohms shall not be acceptable.

5. Control and lighting circuits require only functional tests.
General Electrical Requirements
Section 16010 – 22

6. Branch lighting circuits containing light fixtures and receptacles require only functional tests.

7. Contractor shall check all AC and DC control circuits for short circuits and extraneous grounds.

8. Contractor shall perform functional tests of all power, control, and lighting circuits. Alarm conditions shall be simulated for each alarm and control point, and alarm indicators shall be checked for proper operation. All control circuits shall function as intended by the Contract Documents. Metering and indication lights for motors shall be checked for proper operation. All lighting panels, circuits, lighting fixtures, and receptacles shall be tested for proper operation.

9. The District shall be notified if minimum insulation resistance values are not obtained and if any functional tests fail.

C. Testing Instrumentation, Signal, and Alarm Circuits - 300 V and Below

1. Contractor shall perform continuity checks of all instrumentation, control, signal, and alarm conductors and cables, including each conductor of multi-conductor and multi-pair cables. Continuity checks shall be performed prior to termination of conductors and cables.

2. Contractor shall visually check all conductor and cable connections, verify conductor numbers, and verify actual wiring conforms to the Drawings.

3. Performing insulation resistance tests on conductors and cables will not be required, but functional tests shall be performed.

4. All signal and alarm conditions shall be simulated for each status, alarm and control point, and status/alarm indicators checked for proper operation, similar to that required for control circuits.

5. Contractor shall check all AC and DC instrumentation, signaling and alarm circuits for short circuits and extraneous grounds.

6. The District shall be notified if any functional tests fail.
D. **Motor Testing Prior to Energization**

The following tests shall be conducted prior to starting motors for all motors 5 horsepower and larger:

1. Compare equipment nameplate with the Contract Documents and approved shop drawings.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and grounding.
4. Perform insulation resistance tests in accordance with IEEE 43 of all motor windings before connecting power conductors to motors. Test duration shall be one minute. Insulation resistance shall be a minimum of 50 megohms at 20°C at test voltage of 1000 V DC.
5. Inspect bolted electrical connections for high-resistance using the calibrated torque-wrench method in accordance with manufacturer's published data.
6. Check all bearings to see if they are properly filled with oil or grease.
7. Check coupling alignment and shaft end play.
8. Rotate the motor shaft by hand or bar to ensure it is free to rotate.

E. **Tests Required to be Performed by Independent Testing Consultant (Testing Consultant)**

1. Subsequent to acceptance of equipment installation by the District, the Contractor shall provide a minimum of ten (10) working days written notice of independent third party testing. All terminations required for NETA testing shall be complete. Energizing of tested equipment is at the discretion of the District and will not take place until passed and documented by the Testing Consultant and reviewed by the District. The entire electrical system shall be tested before energization. If functional testing requires power, the Contractor shall provide temporary power for that purpose. All testing shall be completed prior to equipment start up.

2. All references to NETA in this Section are referring to NETA Standard for Acceptance Testing Specifications.

3. The Testing Consultant shall provide a detailed report on all testing per NETA and Section 16040 for District's approval.
4. In addition to and in conjunction with testing and protective device setting per Section 16040, the following tests shall be performed by the Testing Consultant and witnessed by the Contractor and District:

a. Switchboard and Switchgear Assemblies

Perform all inspections and tests, including all optional tests, listed in Section 7.1 of NETA on all Medium-Voltage Switchboards and Switchgear, and Low-Voltage Switchboards and Switchgear.

b. Transformers, Dry-Type, Air-Cooled

Perform all inspections and tests, including all optional tests, listed in applicable Section 7.2.1.1 or 7.2.1.2 of NETA on all dry type transformers.

c. Transformers, Liquid-Filled

Perform all inspections and tests, including all optional tests listed in Section 7.2.2 of NETA on all liquid-filled transformers.

d. Conductors and Cables, Low-Voltage and Medium-Voltage

Perform all inspections and tests, including all optional tests, listed in Sections 7.3.2 and 7.3.3 of NETA on all low-voltage (600 V maximum) and medium-voltage conductors and cables.

e. Circuit Breakers, Insulated-Case/Molded-Case

Perform all inspections and tests (not including optional tests), listed in Section 7.6.1.1 of NETA on all insulated-case/molded-case circuit breakers 100 A frame and higher.

f. Circuit Breakers, Vacuum, Medium-Voltage

Perform all inspections and tests, including all optional tests, listed in section 7.6.3 of NETA on all medium-voltage circuit breakers.

g. Protective Relays, Electromechanical and Solid-State

Perform all inspections and tests, including all optional tests, listed in Section 7.9.1 of NETA on all electromechanical and solid-state protective relays.
h. Protective Relays, Microprocessor-Based

Perform all inspections and tests listed in Section 7.9.2 of NETA on all microprocessor-based protective relays.

i. Metering Devices, Microprocessor-Based

Perform all inspections and tests listed in Section 7.11 of NETA on all metering devices including power monitors.

j. Grounding Systems

Perform all inspections and tests listed in Section 7.13 of NETA on all grounding systems.

k. Ground-Fault Protection Systems, Low-Voltage

Perform all inspections and tests listed in Section 7.14 of NETA on all ground fault protection systems.

l. Rotating Machinery, AC Induction Motors and Generators

Perform all inspections and tests, including all optional tests, listed in Section 7.15.1 of NETA on all low-voltage AC motors and generators 20 HP and larger.

m. Motor Control, Motor Starters, Low-Voltage

Perform all inspections and tests, including all optional tests, listed in Section 7.16.1.1 of NETA on all motor starters. For item 7.16.1.1.6 "Perform operational tests by initiating control devices," the starter control devices (selector switches, pushbuttons, relays, pilot lights, etc.) and motor control wiring shall be tested by simulating field device controls or signals at starter terminal blocks to simulate actual control functionality. Control functionality shall also be checked during field operation testing as described herein, and in accordance with other Sections of the Detailed Provisions.

n. Motor Control, Motor Control Centers, Low-Voltage

Perform all inspections and tests, including all optional tests, listed in Section 7.16.2.1 of NETA on all MCCs.
General Electrical Requirements
Section 16010 – 26

o. Variable Frequency Drives

Perform all inspections and tests, including all optional tests, listed in Section 7.17 of NETA on all Variable Frequency Drives, except for Section 7.17.2.7 which shall be performed by the manufacturer. For item 7.17.2.8 "Perform operational tests by initiating control devices, the VFD control devices (selector switches, pushbuttons, relays, pilot lights, etc.) and motor control wiring shall be tested by simulating field device controls or signals at starter terminal blocks to simulate actual control functionality." Control functionality shall also be checked during field operation testing as described herein, and in accordance with other Sections of the Detailed Provisions.


Perform all inspections and tests listed in Section 7.22.3 of NETA on all Automatic and Manual Transfer Switches, and Manual Bypass Switches.

q. Setting and Testing of Adjustable/Programmable Protective Devices

The Testing Consultant shall set/program and test the adjustable/programmable protective devices in the field according to applicable NETA and manufacturer's requirements and per Section 16040. Contractor shall provide all software and hardware required to set or program devices. The protective devices shall be tested for operation after completion of device setting and programming.

5. In conjunction with the NETA inspections and tests specified above, each bolted connection shall receive Dykem Orange Torque-Seal, or equal, following verification of proper bolt-torque level.

F. Operational Demonstration Testing

Contractor shall demonstrate that the performance of installed electrical materials and equipment complies with requirements specified in Division 16. Operate equipment through entire no-load to full-load range for not less than 4 hours unless a longer period is specified elsewhere. Immediately correct defects and malfunctions with approved methods and materials in each case, and repeat the demonstration. Operational demonstration testing shall conform to the approved demonstration testing plan.
G. **System Validation Testing**

Unless specified otherwise, test all electrical systems for not less than 7 days (168 hours), with no interruptions except for normal maintenance. System validation testing shall conform to the approved test plan. Coordinate testing with equipment validation testing required under Divisions 11 and 16, and under the Special Conditions.

1. **Testing Materials and Equipment**

   Contractor shall furnish all labor, equipment, and materials for required tests, including all instruments, recorders, gauges, chemicals, power, etc.

2. **Testing Methods**

   Contractor shall perform field tests on equipment as specified in the Special Conditions and/or Specification Sections for the specific equipment. Unless specified otherwise, operate systems continuously (24 hours per day) under constant supervision of trained operators and/or field service engineers. Cause variable speed equipment to cycle through the applicable speed range at a steady rate of change. Induce simulated alarm and distressed operating conditions, and test controls and protective devices for correct operation in adjusting system functions or causing system shutdown. Perform other system validation tests as may be required under other Sections of Division 11 and 16, and under the Special Conditions.

3. **Defects**

   Contractor shall immediately correct all defects and malfunctions disclosed by tests. Contractor shall use new parts and materials as required to perform corrective work, as approved by the District. The specified total test period shall be extended by the interruption time for corrective work.

4. **Test Records**

   Contractor shall continuously record all function and operation parameters during the entire test period. Contractor shall submit complete, well organized, and clearly labeled test data to the District for review and approval.

**END OF SECTION 16010**
SPECIFICATIONS - DETAILED PROVISIONS
Section 16040 – Short-Circuit/Coordination Study
and Arc-Flash Hazard Study

CONTENTS

PART 1 - GENERAL ........................................................................................................1
  1.01 SUMMARY ........................................................................................................1
  1.02 DESCRIPTION OF THE WORK ........................................................................1
  1.03 RELATED SECTIONS ........................................................................................3
  1.04 REFERENCE STANDARDS AND CODES ......................................................3
  1.05 SUBMITTALS .....................................................................................................5
  1.06 QUALIFICATIONS ...............................................................................................7

PART 2 – PRODUCTS ..........................................................................................................7
  2.01 GENERAL REQUIREMENTS ..........................................................................7
  2.02 DATA COLLECTION ............................................................................................8
  2.03 SINGLE LINE DIAGRAM ..................................................................................10
  2.04 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY ..........10
  2.05 PROTECTIVE DEVICE COORDINATION STUDY ........................................12
  2.06 ARC-FLASH HAZARD STUDY ........................................................................15
  2.07 STUDY DATA ....................................................................................................17
  2.08 IMPLEMENTATION OF STUDY RESULTS ....................................................20
  2.09 ARC-FLASH AND SHOCK HAZARD LABELS .............................................20

PART 3 - EXECUTION ........................................................................................................ 23
  3.01 PROTECTIVE DEVICE SELECTION AND SETTING ......................................23
  3.02 ARC-FLASH AND SHOCK HAZARD LABEL INSTALLATION ......................24
  3.03 FIELD REPORT ..................................................................................................24

ARC-FLASH LABEL EXAMPLES ...................................................................................... 25
PART 1 - GENERAL

1.01 SUMMARY

A. Contractor shall provide a Short-Circuit and Protective Device Evaluation Study, a Protective Device Coordination Study, and an Arc-Flash Hazard Study, as specified herein.

B. The studies shall be performed for the purposes of estimating the worst case available short-circuit current values and arc-flash incident energy. The studies shall be generated based on information obtained from electrical equipment submittals, actual conductor sizes and lengths for all feeders, utility short circuit current value at the main service switchboard, and information obtained from field reconnaissance of existing equipment/material (if applicable).

C. Contractor shall obtain the short circuit current value at the main service switchboard for the specific project location from the utility. Contractor shall bear all costs associated with obtaining the available short circuit current value.

D. Contractor shall adjust all required protective device settings based on the results of the Protective Device Coordination Study and Arc-Flash Hazard Study.

E. Contractor shall install Arc-Flash and Shock Hazard labels on all electrical equipment, as specified herein.

1.02 DESCRIPTION OF THE WORK

A. Short-Circuit and Protective Device Evaluation Study

1. Contractor shall provide a Short-Circuit and Protective Device Evaluation Study to verify the proposed equipment ratings and protective device ratings.
2. Unless specified otherwise, the scope of the study shall include all proposed distribution equipment supplied under this Contact, as well as all directly affected existing distribution equipment at the District's facility. The study shall include all portions of the existing and proposed electrical distribution system from the electric utility power source(s) and emergency power source(s) down to and including each switchboard, distribution panel, transfer switch (automatic or manual), motor control center, variable frequency drive, distribution panelboard, branch circuit panelboard, busway, enclosed circuit breaker and fused disconnect switch.

B. Protective Device Coordination Study

1. Contractor shall provide a Protective Device Coordination Study to determine and coordinate the selective tripping of protective devices for the proposed equipment.

2. Unless specified otherwise, the scope of the study shall include all proposed distribution equipment supplied under this Contact, as well as all directly affected existing distribution equipment at the District's facility. The study shall include all portions of the existing and proposed electrical distribution system from the electric utility power source(s) and emergency power source(s) down to and including the smallest adjustable trip circuit breaker and fused disconnect switch in the system.

C. Arc-Flash Hazard Study

1. Contractor shall provide an Arc-Flash Hazard Study to determine potential arc-flash incident energies, arc-flash boundaries, shock hazard boundaries; required personal protective equipment (PPE) for all energized electrical equipment; and arc-flash and shock hazard warning labels.

2. Unless specified otherwise, the study shall include all electrical circuits from the electric utility power source(s) and emergency power source(s) to and including all electrical equipment and panelboards rated 208 V and greater.

3. Wherever possible, the proposed electrical equipment shall be designed, manufactured, and supplied to limit the potential arc-flash incident energy to 8 cal/sq cm or less (PPE Category 2). The firm performing the studies shall coordinate with Contractor, the District, and the electrical equipment manufacturers to assist in achieving this requirement.
D. Field Verification

Contractor shall provide the services of an independent testing consultant or firm performing the studies to field verify that all protective devices are set in accordance with the accepted short-circuit/coordination study requirements and recommendations. In addition, the consultant or firm shall verify that all arc-flash and stock hazard labels have been installed.

1.03 RELATED SECTIONS

A. The Contract Documents are a single integrated document, and as such all Specification Sections apply. It is the responsibility of the Contractor and its subcontractors to review all Sections and ensure a complete and coordinated project.

B. Related Specification Sections include, but are not limited to, the following:

1. Division 11 – Equipment
2. Division 16 – Electrical

1.04 REFERENCE STANDARDS AND CODES

Unless specified otherwise, all calculations, analyses, and studies, including application of same to equipment and settings shall meet or exceed the applicable requirements of the following standards and codes (latest edition):

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution for Industrial Plants
2. IEEE 142 – Recommended Practice Grounding of Industrial and Commercial Power Systems
4. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
5. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
6. IEEE 551 – Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems
7. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

B. American National Standards Institute (ANSI):

1. ANSI C37.010 – Standard Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
2. ANSI C37.13 – Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
4. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

C. Code of Federal Regulations:


D. The National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace
1.05 SUBMITTALS

All submittals shall be in accordance with the General Conditions and requirements specified herein.

A. **Computer Software Information**

Submit product literature/brochure for computer software to be utilized for the studies. Submit computer software statement of compliance with IEEE, ANSI, and NFPA 70E standards and requirements.

B. **Qualification Information**

Submit qualification information for firm and individual(s) specified in Part 1.06 herein.

C. **Utility Information**

Submit letter from utility with available short circuit current value at the main service switchboard. As a minimum, the utility letter shall include the following: project address, service voltage and configuration, main service switchboard amperage, short circuit current (3-phase and phase-ground), 3-phase and phase-ground X/R ratios, service transformer kVA and impedance, and service conductor size, number, and length.

D. **Study Results and Report**

The results of the Short-Circuit and Protective Device Evaluation Study, Protective Device Coordination Study, and Arc-Flash Hazard Study shall be summarized in a well-organized, comprehensive report. The report shall address all study requirements specified in Part 2 herein. A sample outline for the report is provided below:

1. Section 1 - Executive Summary

2. Section 2 - Short-Circuit and Protective Device Evaluation Study

   2.1 Short-Circuit Analysis Objectives

   2.2 System Modeling

   2.3 Short-Circuit Results

   2.4 Equipment, Material, and Protective Device Evaluation
3. Section 3 - Protective Device Coordination Study
   3.1 General Description and Protection Philosophy
   3.2 Codes and Standards
   3.3 Coordination Objectives
   3.4 Coordination Results
   3.5 Coordination Recommendations
   3.6 Time-Current Characteristic Plots

4. Section 4 - Recommended Protective Device Settings

5. Section 5 - Short-Circuit Analysis Computer Reports
   5.1 Report Interpretation
   5.2 Short-Circuit Input Data Report
   5.3 Short-Circuit Analysis Results Report - Utility Source
   5.4 Short-Circuit Analysis Results Report - Generator Source
   5.5 Short-Circuit Analysis Results Report - Single-Phase

6. Section 6 - Arc-Flash Hazard Study
   6.1 General Description
   6.2 Analysis Procedure
   6.3 Arc-Flash Analysis Results
   6.4 Arc-Flash Analysis Recommendations
   6.5 Arc-Flash Labels and Location Drawings

7. Section 7 - Single Line Diagrams
   7.1 Power System Study Diagram
   7.2 Reference Drawing Single Line Diagrams

Unless specified otherwise, Contractor shall provide all computer software project study files to the District in electronic format. In addition, a copy of the computer analysis software viewer program shall be provided with the electronic project files, to allow the District to review all aspects of the project and print single line diagrams, arc-flash labels, etc.
E. Coordination of Studies and Equipment Submittals

The Short-Circuit and Protective Device Coordination Studies shall be submitted to the District prior to receiving final acceptance of the related equipment shop drawings and prior to equipment fabrication. If formal completion of the studies may cause delay in equipment fabrication and delivery, approval from the District may be obtained for preliminary submittal of sufficient study data to ensure that the proposed equipment ratings and protective device selection/characteristics will be satisfactory.

1.06 QUALIFICATIONS

A. The firm and individual(s) performing the specified studies shall be experienced in the application of computer software used for power system studies, and shall have performed studies of similar magnitude on electrical systems using similar equipment and devices.

B. The short-circuit, protective device coordination, and arc-flash hazard studies shall be conducted under the direct supervision and control of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. Each study report shall be signed and stamped by the Registered Professional Electrical Engineer.

C. Credentials and background of the firm and individual(s) performing the study shall be submitted to the District for approval prior to commencing the work. A minimum of five (5) years of experience in power system analysis is required for the engineer in charge of the project.

PART 2 – PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Short-Circuit and Protective Device Evaluation Study, Protective Device Coordination Study, and Arc-Flash Hazard Study shall be performed by the same entity.

B. The studies shall be submitted to the District prior to fabrication of any electrical distribution equipment. District's written approval will be required prior to equipment fabrication.

C. Contractor shall be responsible for supplying pertinent electrical system information for proposed equipment/material and existing equipment/material (if applicable).
D. The studies shall include all portions of the electrical system including the electric utility power source and emergency power sources, and contributions from inductive loads on the medium voltage (if applicable) and low voltage (480V) distribution system.

E. All induction motors greater than 50 HP shall be included individually with associated starters and feeder impedance. Unless specified otherwise, all induction motors 50 HP or less and fed from the same bus may be grouped together.

F. Normal system connections and those which result in maximum fault conditions shall be adequately evaluated in the studies.

G. The studies shall be performed using the latest version of the SKM Systems Analysis software (no substitutes). Software shall comply with all applicable IEEE, ANSI, and NFPA 70E standards and requirements.

2.02 DATA COLLECTION

A. Contractor shall be responsible to collect all data as required for the power system studies.

B. The firm performing the system studies shall furnish the Contractor with a listing of the required data immediately after award of the contract and the Contractor shall expedite collection of the data to assure completion of the studies prior to final approval of the distribution equipment shop drawings and/or release of the equipment for manufacture.

C. As a minimum, the following input data shall be collected and tabulated:

1. Product data for overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment names/tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. **Minimum and maximum fault contribution, impedance, and X/R ratio of the electric power utility service transformer.** Rating, type, and settings of the primary overcurrent protective device that protects the service transformer. Conductor data from the protective device to the service transformer. Contractor shall obtain the required electrical service information directly from the electric power utility. Contractor shall be responsible for all coordination and costs associated with obtaining the utility information.

3. Ampacity and interrupting rating in amperes RMS symmetrical for all switchboards, motor control centers, and panelboards.

4. Circuit breaker and fuse current ratings and types within each switchboard, motor control center, panelboard, variable frequency drive, and equipment control panel.

5. Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

6. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

7. Time-current-characteristic curves of protective devices indicated to be coordinated.

8. Distribution system transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

9. Standby generator kVA, size, voltage, source impedance, and thermal-damage curve.

10. Conductors: conduit material, sizes of conductors, number of conductors per phase, conductor material, insulation, and length.

11. Motor horsepower and code letter designation according to NEMA MG 1. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

D. Contractor shall obtain required existing equipment data as necessary to satisfy the study requirements.
2.03 SINGLE LINE DIAGRAM

A. A single line diagram of the electrical distribution system shall be prepared in hard-copy and electronic-copy formats.

B. As a minimum, the single line diagram shall show the following:

1. All individual switchboard, switchgear, motor control center, and panelboard equipment buses with voltage, bus ampere ratings, and short-circuit current ratings.

2. Circuit breaker and fuses with current ratings, amperes interrupting ratings, and types.

3. Motors labeled with horsepower and code letter designation according to NEMA MG 1.

4. Conductor and bus connections between the equipment.

5. Conductor sizes, number of conductors per phase, conductor material and insulation, conductor length, and conduit material.

6. Transformers labeled with size (kVA), voltage, configuration, impedance, and X/R ratio.

7. Generators labeled with size (kVA), voltage, and source impedance.

8. Transfer switches labeled with ampere rating and short-circuit current rating.

2.04 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141.

B. Transformer design impedances shall be used when test impedances are not available.

C. As a minimum, provide the following:

1. Calculation methods and assumptions

2. Selected base per unit quantities
3. Source impedance data, including electric power utility system and motor fault contribution characteristics

4. Tabulations of input data per Part 2.02 and calculated quantities, including fault impedance, X/R ratios, asymmetry factors, motor contributions, generator contributions (if applicable), and symmetrical and asymmetrical fault currents

5. Single line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted

6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric power utility’s supply termination point

2. Incoming switchgear

3. Unit substation primary and secondary terminals

4. Low voltage switchgear and/or switchboard

5. Motor control center

6. Distribution panelboard

7. Branch circuit panelboard

8. Variable frequency drive

9. Standby generator and automatic transfer switch

10. Equipment control panels

11. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
F. Equipment, Material, and Protective Device Evaluations:

1. Evaluate equipment and protective devices and compare to proposed short-circuit ratings.

2. Evaluate adequacy of switchgear, switchboard, motor control center, and panelboard bus bars/bracing to withstand short-circuit stresses.

3. Evaluate adequacy of transformer windings to withstand short-circuit stresses.

4. Evaluate conductors and busways for ability to withstand short-circuit heating.

5. Identify any existing circuit protective devices improperly rated for the calculated available fault current.

6. Tabulate all evaluation results.

2.05 PROTECTIVE DEVICE COORDINATION STUDY

A. Perform the protective device study using the approved computer software program. Utilize the results of the short-circuit analysis. Coordination study shall be performed in compliance with IEEE 399.

1. Model 1/2 cycle network (sub-transient network), 1.5 to 4 cycle network (transient), and 30 cycle network (steady-state network). Calculate 1/2 cycle, 1.5 to 4 cycle, and 30 cycle balanced and unbalanced faults for 3-phase, L-G, L-L, and L-L-G.

2. Calculate the maximum and minimum 1/2 cycle short-circuit currents.

3. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.

4. Calculate the maximum and minimum ground-fault currents.

B. Fault currents and time intervals shall comply with IEEE 241 recommendations.
C. Protect conductors against damage from fault currents according to Insulated Cable Engineers Association (ICEA) Publication P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

D. Protect transformers against damage from through-fault currents according to ANSI C57.109, IEEE C57.12.00, and IEEE 242.

E. Provide computer software generated time-current characteristic (TCC) plots of all overcurrent protective devices on log-log sheets graphically indicating the coordination for all of the key systems.

F. Perform a sequence of operation that evaluates, verifies, and confirms the operation and selectivity of the protective devices for various types of faults via normalized TCC plots and the single-line diagram. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. Establish settings and/or ratings of overcurrent protective devices to achieve selective coordination between devices. Graphically illustrate that adequate time separation exists between devices installed in series, including electric power utility's upstream devices. Prepare separate sets of plots for the switching schemes and for emergency periods where the power source is via the emergency standby generator(s).

H. On each TCC plot, include reference voltage, a complete title, and single line diagram with legend identifying the specific portion of the system covered.

I. Identify the device associated with each curve by device designation/tag, manufacturer, type, and function. Terminate the protective device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device will be exposed.

J. The electric power utility's relay, fuse, or protective device shall be plotted with all load protective devices at the same voltage.

K. Transformer primary protective device, transformer magnetic inrush, transformer ANSI withstand points, secondary voltage fuse or circuit breaker and largest feeder fuse or circuit breaker shall be plotted at the secondary voltage.

L. Fuse curves shall include no damage, melting, and clearing curves as applicable.
M. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short-circuit current.

N. When the main circuit breaker is provided with an arc-flash reduction maintenance system to reduce the arc fault level, both settings shall be included in the study.

O. Low voltage circuit breakers with adjustable overcurrent protection shall have instantaneous, short delay, and long-time pick-up identified on the plot. Low voltage circuit breakers with ground fault protection shall have ground fault trip settings, ground fault ampere, and time delay settings identified on the plot. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified.

P. Feeder circuit breakers shall have the time-damage curve of the feeder conductors plotted to indicate protection of the conductor insulation at the total clearing time of the circuit breaker or fuse. This time-damage point shall be calculated for the specific parameters of conductor insulation used, with average 3 phase RMS asymmetrical amperes at 1/2 cycle calculated using actual resistance and reactance values of the source plus all motor contributions which exist at the load end of the feeder conductors. Conductor initial temperature and conductor maximum transient temperature for short-circuits, as recommended by ICEA, shall be indicated.

Q. The coordination plots shall include significant motor starting characteristics and large motor protective devices.

R. As a minimum, TCC coordination plots shall be provided for the following:

1. Electric power utility’s overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands
4. Low voltage circuit breakers and fuses, including manufacturer’s tolerance bands
5. Transformer full-load and 150, 400, or 600 percent currents, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable

8. Pertinent motor starting characteristics and motor damage points. For motor control circuits, show motor control center full-load current plus symmetrical and asymmetrical of the largest motor starting current and time to ensure protective devices will not trip during major or group start operation.

9. Pertinent generator short-circuit decrement curve and generator damage point, where applicable. Provide phase and ground coordination of the generator protective devices. Obtain the required input information from the generator manufacturer and include the generator actual impedance value, time constants, and current boost data in the study. Do not use typical values for the generator.

10. Other system load protective devices, including branch circuits and feeder circuit breakers in each motor control center, and main circuit breaker in each branch panelboard.

S. A summary tabulation shall be provided listing the designation/tag, manufacturer, and type for all overcurrent and ground fault protective devices, and all recommended settings of each adjustable band included for each device.

T. Provide an evaluation of the degree of system protection and service continuity possible with the overcurrent devices supplied.

2.06 ARC-FLASH HAZARD STUDY

A. The arc-flash hazard study shall be performed according to the IEEE 1584 guidelines and equations presented in NFPA 70E-2015, Annex D. The analysis shall be performed in conjunction with the Short-Circuit and Protective Device Evaluation Study, and the Protective Device Coordination Study.

B. The flash-protection boundary and the incident energy shall be calculated at all equipment locations in the electrical distribution system where work could be performed on energized parts, including, but not limited to, the following: switchboards, switchgear, motor control centers, panelboards, busway and splitters, and equipment control panels.

C. The Arc-Flash Hazard Study shall include all medium voltage, locations, all 480V locations, and all 240V and/or 208V locations. In addition, the Arc-Flash Hazard Study shall include all DC locations of 50V or greater.
D. Safe working distances shall be based upon the calculated arc-flash boundary considering an incident energy of 1.2 cal/sq cm.

E. When appropriate, the short-circuit calculations and the clearing times of the overcurrent protective devices shall be retrieved from the short-circuit and protective device coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios shall be compared, and the greatest incident energy shall be uniquely reported for each equipment location. Calculations shall be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation shall assume that the electric power utility contribution is at a minimum and shall assume a minimum motor contribution (all motors off). Conversely, the maximum calculation shall assume a maximum contribution from the electric power utility and shall assume the maximum amount of motors to be operating under full-load conditions. Calculations shall take into consideration the parallel operation of synchronous generators with the electric power utility, where applicable.

G. The incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.

2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash-protection boundary shall include both the line and load side of the main breaker.
I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions shall be included in the fault calculation.

J. Mis-coordination shall be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation shall utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc-flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584, Section B.1.2. Where it is not physically possible to move outside of the flash-protection boundary in less than 2 seconds during an arc-flash event, a maximum clearing time based on the specific location shall be utilized.

L. Determine incident energy and arc-flash PPE requirements for each equipment location. For main circuit breakers with arc-flash reduction maintenance systems, determine two (2) incident energies (one for normal duty and one for maintenance duty).

M. Calculate shock hazard approach boundaries (limited approach boundary and restricted approach boundary) for each equipment location.

N. Provide recommendations to reduce arc-flash hazard energy and exposure.

O. Coordinate with manufacturers/suppliers of the electrical equipment.

2.07 STUDY DATA

The results of all study calculations, analyses, evaluations, and determinations specified in Part 2 herein shall be presented in a detailed, comprehensive report. In addition, data from the computer software analyses shall be included in the study report along with data evaluation and recommendations. Computer analysis data, data evaluation, and recommendations shall include, but not be limited to, the following:

A. Study Input Data

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).

2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, percent taps and phase shift.
3. Reactor data, including voltage rating, and impedance.

4. Generation contribution data, (synchronous generators and electric power utility), including short-circuit reactance (X”d), rated MVA, rated voltage, three-phase and single-line to ground contribution (for electric power utility sources) and X/R ratio.

5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Study

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   
   a. Voltage (600V and less)

   b. Calculated fault current magnitude and angle

   c. Fault point X/R ratio

   d. Equivalent impedance

2. Momentary (First Half-Cycle) Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

   a. Voltage (greater than 600V)

   b. Calculated symmetrical fault current magnitude and angle

   c. Fault point X/R ratio

   d. Calculated asymmetrical fault currents

   - Based on fault point X/R ratio
   - Based on calculated symmetrical value multiplied by 1.6
   - Based on calculated symmetrical value multiplied by 2.7

   e. Equivalent impedance
3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

   a. Voltage (greater than 600V)
   b. Calculated symmetrical fault current magnitude and angle
   c. Fault point X/R ratio
   d. No AC decrement (NACD) ratio
   e. Equivalent impedance
   f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
   g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis.

C. Protective Device Coordinating Study:

1. Recommendations for Phase and Ground Relays:

   a. Current transformer ratio
   b. Current setting
   c. Time setting
   d. Instantaneous setting
   e. Recommendations on improved relaying systems, if applicable.

2. Recommendations for Circuit Breakers:

   a. Adjustable pickups and time delays (long time, short time, ground)
   b. Adjustable time-current characteristic
   c. Adjustable instantaneous pickup
   d. Recommendations on improved trip systems, if applicable.
D. Arc-Flash Hazard Study:

1. Incident Energy Calculations:
   a. Arcing fault magnitude
   b. Protective device clearing time
   c. Duration of arc
   d. Incident energy

2. Arc-Flash Protection Boundary Calculations and Recommendations:
   a. Arc-flash boundary
   b. Shock hazard approach boundaries
   c. Personal protective equipment
   d. Recommendations for arc-flash energy reduction.

2.08 IMPLEMENTATION OF STUDY RESULTS

Prior to fabrication, Contractor shall coordinate the study results with the manufacturers and suppliers of electrical equipment to incorporate the recommendations and modifications therein.

2.09 ARC-FLASH AND SHOCK HAZARD LABELS

A. General

1. Labels shall be 4" x 6" thermal transfer type labels of UV resistant high adhesion polyester. Labels shall be machine printed, with no field markings.

2. Labels shall comply with the requirements of the NEC, NPFA 70E, and ANSI Z535.4.

3. All labels shall be based on recommended overcurrent protective device settings and shall be provided after the results of the analyses have been accepted by the District and after any system changes, upgrades or modifications have been incorporated into the system.
4. In general, the arc-flash labels shall be based on the maximum calculated incident energies for the worst case operating scenario. However, where arc-flash reduction maintenance systems are specified, provide two (2) sets of arc-flash labels (one for normal duty and one for maintenance duty).

5. The firm performing the Study shall provide all labels. Equipment elevations drawings showing the location of each label shall be prepared by the firm performing the Study.

6. For outdoor electrical panels with interior enclosures and outer NEMA 3R wrappers, labels shall be provided on both outer and inner doors, as follows:
   
a. For incident energy levels less than 40 cal/sq cm, each outer door section shall be provided with a warning label stating "WARNING, ARC-FLASH AND SHOCK HAZARD, APPROPRIATE PPE REQUIRED". The label color scheme shall match the inner arc-flash warning label.

   b. For incident energy levels greater than 40 cal/sq cm, each outer door section shall be provided with a danger label stating "DANGER, ARC-FLASH AND SHOCK HAZARD, NO SAFE PPE EXISTS, ENERGIZED WORK PROHIBITED". The label color scheme shall match the inner arc-flash danger label.

   c. Inner doors shall be provided with arc-flash labels as specified in Parts B and C below.

7. Labels shall be provided for each switchboard, distribution panel, transfer switch (automatic or manual), motor control center, variable frequency drive, distribution panelboard, branch circuit panelboard, busway, enclosed circuit breaker and disconnect switch in a readily visible location in accordance with NEC and OSHA requirements.

8. Where incident energy levels vary across a panel line-up, such as a motor control center, a separate label shall be provided for each section or compartment with a different incident energy level. As a minimum, labels shall be installed every four feet.

B. Warning Labels

1. Warning labels shall be white with an orange stripe and black letters. A sample warning label is presented at the end of this Section.
2. Warning labels shall include the following information:
   
   a. "WARNING, ARC-FLASH AND SHOCK HAZARDS, APPROPRIATE PPE REQUIRED".
   
   b. Arc-flash hazard boundary.
   
   c. Available incident energy (cal/sq cm) and working distance.
   
   d. Recommended (minimum) PPE from NFPA Table 70E H.3(b)
   
   e. Maximum available fault current (Isc).
   
   f. Shock hazard when cover is removed.
   
   g. Glove class.
   
   h. Limited approach distance.
   
   i. Restricted approach distance.
   
   j. Equipment description and location.
   
   k. Protective device description.
   
   l. Operating scenario.
   
   m. Firm identification (prepared by).
   
   n. Label preparation date.

C. Danger Labels

1. Danger labels shall be white with a red warning stripe and black letters. A sample danger label is presented at the end of this Section.

2. Danger labels shall include the following information:

   a. "DANGER, ARC-FLASH AND SHOCK HAZARDS, ENERGIZED WORK PROHIBITED".
   
   b. Arc-flash hazard boundary.
   
   c. Available incident energy (cal/sq cm) and working distance.
d. No safe PPE exists – Do not work on equipment while energized.

e. Available fault current (Isc).

f. Shock hazard when cover is removed.

g. Glove class.

h. Limited approach distance.

i. Restricted approach distance.

j. Equipment description and location.

k. Protective device description.

l. Operating Scenario.

m. Firm identification (prepared by).

n. Label preparation date.

**PART 3 - EXECUTION**

**3.01 PROTECTIVE DEVICE SELECTION AND SETTING**

A. Field setting of the protective devices shall be performed as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study, and protective device coordination study. Confirmation of protective device selection and performance of device field setting shall be witnessed and verified by the testing consultant performing electrical system testing (reference Specification Section 16010) or by the firm performing the studies.

B. Contractor shall set all relays, overcurrent devices and ground fault protection devices, and confirm selection of fuse overcurrent devices as follows:

1. **Relays:** Reset all adjustable relay settings from factory defaults settings to the settings recommended in the studies specified herein.

2. **Circuit Breakers:** Reset all adjustable trip settings from factory default settings to the settings recommended in the studies specified herein.
3. Ground Fault Protection Devices: Reset all adjustable device settings from the factory defaults settings to the settings recommended in the studies specified herein.

4. Fuses: Confirm that fuse types installed on the project are as recommended in the studies specified herein.

C. Necessary field adjustments of devices and minor modifications to equipment to accomplish conformance with the approved studies shall be performed at no additional cost to the District.

D. Contractor shall verify the proper short-circuit duty and amperage rating of all protective devices and bussing. Equipment short-circuit duty and amperage ratings shall be in accordance with the Drawings and equipment specifications, and shall meet or exceed the ratings recommended in the studies specified herein.

3.02 ARC-FLASH AND SHOCK HAZARD LABEL INSTALLATION

A. Affix arc-flash and shock hazard labels to all electrical equipment as required by NFPA 70 and NFPA 70E.

B. Install labels in accordance with the approved label location drawings and as specified herein.

3.03 FIELD REPORT

The firm witnessing the confirmation of protective device selection and performance of device field setting shall provide a detailed report showing that selections and settings of protective devices are in compliance with the studies and requirements specified herein. In addition, the report shall include a photographic record of all installed arc-flash labels, including locations. The report shall be submitted to the District for acceptance as a submittal document.
**ARC-FLASH LABEL EXAMPLES**

### WARNING

**Qualified Persons Only**

Arc-Flash and Shock Hazards  
Appropriate PPE Required

**REVIEW SAFE WORK PRACTICES PRIOR TO WORK**

<table>
<thead>
<tr>
<th>44 in</th>
<th>Arc-Flash Hazard Boundary</th>
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</thead>
<tbody>
<tr>
<td>7.1 cal/cm²</td>
<td>Arc-Flash Incident Energy at Work Distance: 18 inches</td>
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<tr>
<td>5.85 kA</td>
<td>Maximum Available Fault Current</td>
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</tbody>
</table>

**Recommended (Minimum) PPE:** Arc-rated long sleeve shirt and arc-rated pants, or arc-rated coverall and/or arc-flash suit. Arc-rated arc-flash suit hood, arc-rated gloves, arc-rated jacket, parka, or rainwear. Hard hat, arc-rated hard hat liner, safety glasses, hearing protection, arc-rated gloves, and leather footwear.

<table>
<thead>
<tr>
<th>480 VAC</th>
<th>Shock Hazard when Cover is Removed</th>
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<tbody>
<tr>
<td>00</td>
<td>Glove Class</td>
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</table>

<table>
<thead>
<tr>
<th>42 in</th>
<th>Limited Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 in</td>
<td>Restricted Approach</td>
</tr>
</tbody>
</table>

**Equipment/Device Name:** MCC-2A  
**Feed From:** MDP-1  
**Scenario 2 - Normal Power**

**Study Performed by:** ACME Flash, Inc.  
**Prepared:** 02/12/16

### DANGER

Arc-Flash and Shock Hazards  
Energized Work Prohibited

<table>
<thead>
<tr>
<th>207 in</th>
<th>Arc-Flash Hazard Boundary</th>
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<tbody>
<tr>
<td>65 cal/cm²</td>
<td>Arc-Flash Incident Energy at Work Distance: 18 inches</td>
</tr>
<tr>
<td>43.8 kA</td>
<td>Maximum Available Fault Current</td>
</tr>
</tbody>
</table>

**Recommended (Minimum) PPE:** No Safe PPE Exists - Do Not Work On Equipment While Energized!

<table>
<thead>
<tr>
<th>480 VAC</th>
<th>Shock Hazard when Cover is Removed</th>
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<tbody>
<tr>
<td>00</td>
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</thead>
<tbody>
<tr>
<td>12 in</td>
<td>Restricted Approach</td>
</tr>
</tbody>
</table>

**Equipment/Device Name:** Main CB  
**Feed From:** Service Switchboard  
**Scenario 2 - Normal Power**

**Study Performed by:** ACME Flash, Inc.  
**Prepared:** 02/12/16

END OF SECTION
SECTION 16051
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

A. This section specifies the requirements for the fabrication, assembly, delivery, testing, and installation of electrical equipment and material necessary for the electrical work of this Contract.

B. Contractor shall furnish all labor, supervision, materials, equipment, tests and services to install electrical equipment and material, as specified herein and shown on the Drawings.

1.02 RELATED SECTIONS

A. The Contract Documents are a single integrated document, and as such all Specification Sections apply. It is the responsibility of the Contractor and its subcontractors to review all sections and ensure a complete and coordinated project.

B. Related Specification Sections include, but are not limited to, the following:

1. Sections of the Specifications specifying equipment and/or systems requiring electrical work, including basic electrical materials and equipment.

2. Division 16 – Electrical

3. Division 17 – Instrumentation and Controls

1.03 STANDARDS AND CODES

A. All materials and equipment, including installation of same, shall meet or exceed the applicable requirements of the following standards and codes (latest edition):

1. ANSI American National Standards Institute

2. ASTM American Society for Testing and Materials
4. ICEA Insulated Cable Engineers Association
5. IEEE Institute of Electrical and Electronic Engineers
6. IESNA Illuminating Engineering Society of North America
7. NEIS National Electrical Installation Standards
8. NEMA National Electrical Manufacturers Association
9. NEC National Electrical Code (NFPA 70)
10. NETA National Electric Testing Association (NETA)
11. NFPA 70E Standard for Electrical Safety in the Workplace
12. NIST National Institute of Standards and Technology
13. OSHA Occupational Safety and Health Administration (Federal and State)
14. UL Underwriters Laboratories

B. Underwriters' Laboratories Approval: All material and equipment furnished by the Contractor shall be listed by and shall bear the label of Underwriters Laboratories (UL) or Edison Testing Labs (ETL).

C. All electrical materials and equipment, and the design, construction, and installation thereof, shall comply with all applicable provisions of the Federal Occupational Safety and Health Administration (OSHA), and California Occupational Safety and Health Administration (Cal OSHA).

D. Where the Drawings or these Specifications call for material, equipment and workmanship to be of better quality or higher standard than required by the above standards and codes, and applicable rules and regulations, then said Drawings and Specifications shall prevail. Nothing on the Drawings or in these Specifications shall be construed to permit work in violation of the above standards and codes.

E. In the event of a conflict or disagreement between the Drawings and Specifications; and standards; codes; federal, state, and local laws and
ordnances; utility company regulations; or industry standards; the most stringent requirements shall govern. The Contractor shall promptly notify the District in writing of such differences.

1.04 SUBMITTALS

All submittals shall be in accordance with the General Conditions, Section F - Labor and Construction, and requirements specified herein.

Submit for the District's approval material lists, shop drawings, factory test reports and technical data to the extent required in this Section, Section 16010, and the General Conditions.

A. Shop Drawings

Contractor shall submit complete information, drawings, and technical data for all material and equipment, including, but not limited to, the following:

1. Manufacturer’s product literature and specifications for all material and equipment required for the project. Product literature and specifications shall be marked to clearly identify all applicable information and crossing out all inapplicable information. Applicable sizes, model numbers, and options shall be clearly marked. Sufficient data and detail shall be provided to demonstrate compliance with these Specifications.

2. Interconnection wiring diagrams (loop diagrams) showing all interconnections between equipment, control panels, RTU, electrical switchgear, MCCs, field instrumentation, etc. Diagrams shall be provided with wire numbers and terminal block numbers.

3. Electrical control drawings, including complete control ladder diagrams and complete interconnect diagrams with appropriate wire and terminal numbering. Control ladder diagrams shall be provided with numbers for each line, including references to the line number where contacts for each relay are shown. Ladder diagrams shall show wire numbers, terminal blocks, and terminal block numbers.

4. Schematic wiring diagrams for all local control stations. Schematic wiring diagrams shall clearly identify internal and external devices, and all remote contacts and signals.

5. Nameplate schedule for all local control stations, including nameplate material, lettering height, and proposed inscriptions.
6. Conduit tag schedule for all conduit tags, listing the proposed engraving for each conduit tag.

7. Conductor identification marker schedule for all field conductors, listing the proposed identification for each conductor at each terminal point.

8. Pull box and manhole schedule, listing all proposed pull boxes and manholes. Schedule shall include structure size and depth, type of cover, cover load rating, and special features (if any).

9. Duct bank drawings and cross sections of all electrical duct banks (two (2) conduits or more). Cross sections shall be provided at each pull box and manhole (entrance and exit). Each conduit in the duct bank cross section shall be labeled. Elevations to the nearest 0.1' shall be provided at the top and bottom of each duct bank cross section.

10. Drawings for all grounding work not specifically shown on the Contract Drawings.

B. Operation and Maintenance Manuals

Contractor shall submit detailed Operation and Maintenance Manuals for each item of equipment in accordance with the General Conditions.

C. Record Drawings

Contractor shall maintain and keep current a complete record set of construction drawings showing every change from the Contract Drawings and Specifications and the exact locations, sizes, and types of equipment and material installed. Record drawings shall show all conduit runs (sizes and number), circuits, and conductors (sizes and numbers). Record drawings shall show depths and routing of all concealed and belowgrade electrical installations. Record drawings shall be available to the District during construction and shall be delivered to the District upon project completion.

1.05 COORDINATION OF WORK AND TRADES

A. Electrical work shall be performed in cooperation with all other trades so that a neat and orderly arrangement of the work as a whole shall be obtained.

B. Prior to commencing work, the Contractor shall verify with the equipment manufacturers that equipment dimensions and arrangements will allow for
equipment installation in the spaces shown on the Drawings for all motor control centers, variable frequency drives, switchboards, panelboards, control panels, transformers, and other major items of electrical equipment, and that the installation indicated will provide for all required ventilation, clearances, access, and work space.

C. Before installing any equipment, materials, or raceways, the Contractor shall carefully examine the complete set of Drawings and Specifications, and approved equipment shop drawings and confirm connection methods, and all dimensions and space requirements. Contractor shall confirm size and type of equipment conduit connectors with proposed conduit material and sizes. In addition, Contractor shall confirm stub-up areas beneath equipment panels and areas marked for direct conduit connection, with the proposed number and size of conduit.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery

Deliver electrical materials and equipment in manufacturer's original cartons and containers with seals intact. Deliver conductors on sealed reels. Deliver large multi-component equipment in sections to facilitate field handling and installation.

B. Storage

Unless designed for outdoor exposure, store electrical equipment and material on the ground and under cover. Equipment and material shall be protected from weather, corrosion, contamination, and deterioration. Dents, marred finishes, and other damage shall be repaired to its original condition or replaced as directed by the District.

C. Handling

All equipment and material shall be handled in accordance with the manufacturer's recommendations. Large or heavy items shall be lifted at the points designed by the manufacturer. Equipment and material shall be handled and installed as necessary to prevent damage.
PART 2 - PRODUCTS

2.01 GENERAL

Except as may be specifically indicated otherwise, materials and products furnished under this section shall be new and in accordance with the standards as herein before specified. Products used for the same purpose shall be of the same manufacturer and make. Outdoor equipment, fixtures and wiring devices shall be of approved weatherproof construction or shall be in weatherproof enclosures.

A. Standard Products

Materials and products submitted for approval shall be the cataloged products of companies regularly engaged in the manufacture of such items, shall be the latest standard design that conforms to the specification requirements and shall essentially duplicate materials and products that have been in satisfactory use for at least 2 years.

B. Approved Manufacturers

Wherever on the Drawings or in the Specifications, materials or equipment are identified by the names of one or more manufacturers, it is intended that only these manufacturers will be acceptable. Equal materials or equipment of other manufacturers may be submitted for consideration by the District at least 30 days prior to bid.

2.02 CONDUCTORS AND CABLES

A. General

Conductors and cables shall be new, single conductor, copper, not smaller than #14 AWG (except shielded control wire) unless indicated otherwise on the Drawings. Aluminum conductors and cables are not acceptable.

Conductor insulation shall bear manufacturer's trademark, insulation designation, voltage rating, and conductor size at regular intervals. Each type of conductor or cable shall be the product of a single manufacturer.
B. **Conductors Smaller than 250 MCM**

1. **Above Grade**

   Conductors smaller than 250 MCM for power service, power feeders, power circuits, lighting feeders, lighting circuits, and control circuits shall be stranded copper, rated 600 volt, with 75°C THWN insulation, UL approved, for installation underground, in concrete, in masonry, or in wet locations.

2. **Below Grade**

   Conductors smaller than 250 MCM for power service, power feeders, power circuits, lighting feeders, lighting circuits, and control circuits shall be stranded copper, rated 600 volt, with 90°C XHHW-2 insulation, UL approved, for installation underground, in concrete, in masonry, or in wet locations. If any portion of the conduit/conductor routing is underground, the entire length of conductor shall be considered underground, and shall be provided with 90°C XHHW-2 insulation (no splices allowed).

C. **Conductors 250 MCM and Larger**

1. **Above Grade**

   Conductors 250 MCM and larger shall be stranded copper, rated 600 volt, with 75°C THHN or THWN insulation, UL approved, for installation underground, in concrete, in masonry, or in wet locations.

2. **Below Grade**

   Conductors 250 MCM and larger shall be stranded copper, rated 600 volt, with 90°C XHHW-2 or XLP insulation, UL approved, for installation underground, in concrete, in masonry, or in wet locations. If any portion of the conduit/conductor routing is underground, the entire length of conductor shall be considered underground, and shall be provided with 90°C XHHW-2 or XLP insulation (no splices allowed).

D. **High Temperature Conductors**

High temperature conductors shall be provided where indicated on the Drawings. High temperature conductors shall be stranded copper, rated 600V, with 90°C XHHW-2 insulation, and UL approved. High temperature conductors
shall only be utilized to compensate for ambient temperature correction factors and adjustment factors per NEC Article 310 with conductors sized based on 75°C ampacity per NEC Tables 310.15(B)(16) and 310.15(B)(17), unless all electrical system connectors, terminals, and lugs for high temperature conductors are rated 90°C.

E. **Ground Conductors and Neutral Conductors**

Ground conductors shall be provided for required ground wiring.

Unless specified otherwise, equipment ground conductors shall be stranded copper, rated 600V, UL approved, for installation underground, in concrete, in masonry, or in wet locations. All conductors installed underground shall be provided with 75°C XHHW insulation. Conductors installed aboveground shall be provided with 75°C XHHW or THWN insulation. Equipment ground conductors shall be identified by a continuous green insulation color.

Structure and building ground system conductors shall be stranded bare copper. Minimum conductor size shall be #1/0 AWG.

Neutral conductors shall be stranded copper, rated 600V, UL approved, for installation underground, in concrete, in masonry, or in wet locations. All conductors installed underground shall be provided with 75°C XHHW insulation. Conductors installed aboveground shall be provided with 75°C XHHW or THWN insulation. Neutral conductors shall be identified by a continuous white insulation color.

F. **Instrumentation Signal Cables**

Instrumentation signal cables shall be single twisted pair or multi-twisted pairs of stranded, 600V, copper cables with 15 mil polyvinyl chloride insulation over each conductor, overall aluminum-mylar tape shield, overall tinned copper drain wire and 45 mil minimum polyvinyl chloride jacket overall. Twisted pair cables that are required to be shielded, shall have aluminum-mylar tape shields and tinned copper drain wires over individual twisted pairs of cable. Single twisted pair cables shall be #16 AWG minimum. Instrumentation signal cables installed underground shall be tray cable (TC) rated and UL 1277 listed. Unless indicated otherwise on the Drawings, instrumentation signal cable shall be used for all 4-20 mA signals. Cables shall be manufactured by Belden, Okonite, or equal.

G. **Fine Stranded Conductors**

Fine stranded conductors, Class C and higher (such as DLO cable), shall only be installed where specifically indicated on the Drawings. All terminations of fine
stranded conductors shall be provided with copper flex-cable compression adapters to properly confine the fine strands and prevent overheating of the connection and wire pullout from mechanical lugs. The flex-cable compression adapters shall fit mechanical set-screw mechanical lug type connectors and shall be sized for the full current carrying capacity of the cable. The adapters shall be provided a flared barrel-opening to allow easy cable insertion. The adapter shall be constructed of wrought copper with pin of Class B stranded copper conductor, rated for 600V and 105° C cable, and shall be UL listed. Pin length shall be sufficient to allow full engagement into the mechanical lug. Flex-cable copper compression adapters shall be Shoo-pin PT-FX Series, as manufactured by Greaves Corporation, or equal.

Welding cable shall not be used unless factory installed.

H. Color Coding

System conductors shall be factory color coded by integral insulation pigmentation with a separate color as specified herein. Conductors #6 AWG and larger may be color coded with an approved colored marking tape at all terminations and in all junction boxes, pull boxes, and manholes. Each voltage system shall have a color coded system that shall be maintained throughout the project. Approved conductor colors are as follows:

<table>
<thead>
<tr>
<th>Power System</th>
<th>Service</th>
<th>Color</th>
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</thead>
<tbody>
<tr>
<td>480V, 3 Phase, 4 Wire</td>
<td>Phase A</td>
<td>Brown</td>
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<tr>
<td></td>
<td>Phase B</td>
<td>Orange</td>
</tr>
<tr>
<td></td>
<td>Phase C</td>
<td>Yellow</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>White</td>
</tr>
<tr>
<td>120/208/240V, 3 Phase, 4 Wire</td>
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</tr>
<tr>
<td></td>
<td>Phase B</td>
<td>Red</td>
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<tr>
<td></td>
<td>Phase C</td>
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<td></td>
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<tr>
<td>All Equipment</td>
<td>Ground</td>
<td>Green</td>
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<tr>
<td>All System</td>
<td>Ground</td>
<td>Bare Copper</td>
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<table>
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<tr>
<th>Control System</th>
<th>Service</th>
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<td>Blue</td>
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<td></td>
<td>Digital Output</td>
<td>Brown</td>
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### Power System

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<td>277V</td>
<td>Switched Leg</td>
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</table>

### 2.03 CONDUCTOR AND CABLE CONNECTORS

Connectors shall be provided for splices and terminal connections of all copper conductors and cables. The connector shall be designed to fit the conductor to which it shall be connected.

#### A. Compression Connectors

1. Connectors for #8 AWG and larger conductors shall be non-insulated compression type constructed of copper and tin-plated. Connector voltage and amperage ratings shall be equal to, or greater than, the conductor ratings. Connectors shall be one-hole, flat-tongue style lugs for terminal connections, and two-way sleeves for splice connections.

   Non-insulated compression type splice connectors shall be taped with two layers of half lapped liner-less rubber splicing tape and provided with a cold shrink connector insulator sleeve (pre-slipped over the conductor) over the splice connector. Cold shrink insulators shall be as manufactured by 3M Company, or equal.

2. Connectors for #10 AWG and smaller conductors shall be pre-insulated compression type constructed of copper and tin-plated. Connector voltage and amperage ratings shall be equal to, or greater than, the conductor ratings. Connectors shall be split-tongue type for terminal connections, and two-way sleeves for splice connections.

3. Connectors shall be similar to Thomas & Betts "Sta-Kon", or equal. Connectors shall be installed using manufacturer’s crimping tools and accessories.
4. Waterproofed splices shall be constructed with cold shrink insulators encapsulated in epoxy resin. Epoxy resin splice kits shall be 3M Scotchkote 82 Series, or equal.

B. **Tapered Coil Spring Connectors**

Connectors shall have live coil springs, flame retardant thermoplastic shells rated for 105°C, and shall be UL listed. Connectors shall be provided for #10 AWG and smaller conductors for lighting and receptacles. Connectors shall be as manufactured by Buchanan, Thomas & Betts, Ideal, or equal.

C. **Shielded Cable Terminations**

Shielded cable shall be terminated with pre-assembled stress cones. Stress cone terminations shall be IEEE Class 1 molded rubber type. Stress cone terminations shall be approved by the cable manufacturer. Contractor shall submit its proposed termination procedures with shop drawings for shielded cable. Stress cone terminations shall be as manufactured by 3M Company, Raychem, or equal.

D. **Electrical Tape**

Electrical tape shall be premium grade, 7 mil thick, all-weather vinyl-insulating tape. Tape shall be designed to perform continuously in ambient temperatures up to 105°C, and shall be resistant to abrasion, moisture, alkalies, acids, corrosion, and varying weather conditions (including ultraviolet exposure). The tape shall be compatible with synthetic cable insulations, jackets and splicing compounds, and shall be UL listed. The tape shall be Scotch Super 33 Plus, or equal.

**2.04 CONDUCTOR AND CABLE MARKERS**

Markers shall be provided to identify all conductors and cables at equipment terminals, and in junction boxes, pull boxes, and manholes. The conductor and cable markers shall be one uniform standardized marking system. Heat shrinking of the markers and clear tubing shall be in accordance with manufacturer's specifications. The field installed conductor and marker number shall be labeled with the same number as the terminal it is connected to.
A. Markers

The marking system shall consist of heat shrinkable flame retarded identification sleeves that fit tightly over the conductor or cable to be marked. Marker sleeves shall be made of a seamless cross-linked polyolefin with a 3 to 1 shrink ratio.

Conductor and cable marker system shall be UL recognized to Standard 224, MIL-M-81531. Markers shall be smear resistant prior to shrinking and achieve a permanent mark when shrunk, without the need for permatizing equipment. Markers shall be seamless. Markers shall be resistant to common industrial fluids including Freon TF, Isopropyl Alcohol and Ethylene Glycol. Markers shall have a temperature range of -30°C to 105°C and a dielectric strength of 500 V/mil minute. Marks shall be legible after 20 eraser rubs and 30 solvent brush strokes. The markers shall be suitable for indoor or outdoor use. The conductor and cable marker system shall be as manufactured by Raychem/Kroy Cable Marking, or Brady -Permasleeve White Polyolefin (B-342), or equal. Heat shrinkable thermoplastic tags are not acceptable.

B. Clear Tubing

Adhesive type cable markers are not acceptable by themselves. To provide a long-term permanent marker in high ambient temperatures, a translucent (clear) shrink tube shall be placed over each wire marker (extending past both edges of adhesive wire marker) and heat shrunk. The clear tube shall be suitable for high temperature performance, abrasion resistance and cut-through resistance and resistant to chemicals and solvents. The clear tubing shall meet the high temperature performance that meets or exceeds military industrial standards: MIL-1-23053, Test C, with UL VW-1 ratings. Operating temperature range shall be -55°C to 175°C. Product shall be Kynar as manufactured by Raychem, or equal.

2.05 METAL CONDUITS

Each length of conduit shall bear the manufacturer’s name and UL label. Minimum conduit size shall be 3/4", unless noted otherwise. Conduit ends shall be threaded. Unless specified otherwise, elbows shall be standard radius sweeps meeting the requirements of the NEC.

A. Rigid Galvanized Steel (RGS) Conduit

1. RGS conduit, couplings, elbows, bends, and nipples shall be in accordance with ANSI C80.1 and UL 6, and shall be hot-dipped galvanized inside and out.
2. RGS conduit ends shall be threaded. Threads shall be hot galvanized after cutting. Color-coded end caps shall be provided to protect conduit threads. Thread-less fittings are not acceptable. A hot-dipped galvanized threaded coupling shall be furnished with each length of conduit.

3. All conduit cut ends shall be reamed or otherwise finished to remove rough edges. Where conduit is threaded in the field, a standard cutting die with NPT tapered threads (3/4-in. taper per foot) shall be used. Running threads are not acceptable.

4. Conduit, couplings, elbows, bends, and nipples shall be as manufactured by Allied Tube & Conduit, Wheatland Tube, Conduit Pipe Products Company, or equal.

B. PVC Coated Rigid Galvanized Steel (PVC-RGS) Conduit

1. PVC-RGS conduit, couplings, elbows, bends, nipples, and connectors shall be in accordance with ANSI C80.1, UL 6 and NEMA RN-1, and shall be hot-dipped galvanized inside and out. A PVC coating of 40 mils (minimum) thickness shall be bonded to the outer galvanized surface of the conduit and a urethane coating of 2 mils (minimum) thickness shall be applied to the interior surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic.

2. PVC-RGS conduit ends shall be threaded. A PVC-coated threaded coupling shall be furnished with each length of conduit. A PVC sleeve equal to the OD of the conduit shall extend 2 inches from each end of the coupling.

3. Factory threaded ends shall be provided a urethane coating. Field cut threads shall be coated as specified in Part 3 herein.

4. Conduit, couplings, elbows, bends, nipples, and connectors shall be as manufactured by Ocal, Perma-Cote, Rob-Roy, or equal.

C. Rigid Aluminum (RA) Conduit

1. RA conduit, couplings, elbows, bends, and nipples shall be in accordance with ANSI C80.5 and UL 6A. RA conduit, couplings, elbows, bends, and nipples shall be constructed of aluminum 6063 alloy in temper designation T-1.
2. RA conduit ends shall be threaded. A threaded coupling shall be furnished with each length of conduit. A graphite based lubricant shall be factory applied to the threads at each end of the conduit. Color-coded end caps shall be provided to protect threads.

3. All conduit cut ends shall be reamed or otherwise finished to remove rough edges. Where conduit is threaded in the field, a standard cutting die with tapered threads (3/4-in. taper per foot) shall be used. Running threads are not acceptable.

4. All RA conduit in direct contact with the ground, concrete, or grout shall be PVC coated as specified herein. Alternatively, RA conduit may be protected by double wrapping with 20 mil PVC tape.

5. RA conduit, couplings, elbows, bends, and nipples shall be as manufactured by Allied Tube & Conduit, Wheatland Tube, Conduit Pipe Products Company, or equal.

D. PVC Coated Rigid Aluminum (PVC-RA) Conduit

1. PVC-RA conduit, couplings, elbows, bends, nipples, and connectors shall be in accordance with ANSI C80.5, UL 6A and NEMA RN-1. A PVC coating of 40 mils (minimum) thickness shall be bonded to the outer surface of the conduit and a urethane coating of 2 mils (minimum) thickness shall be applied to the interior surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic.

2. PVC-RA conduit ends shall be threaded. A PVC-coated threaded coupling shall be furnished with each length of conduit. A PVC sleeve equal to the OD of the conduit shall extend 2 inches from each end of the coupling.

3. Factory threaded ends shall be provided a urethane coating. Field cut threads shall be coated as specified in Part 3 herein.

4. Conduit, couplings, elbows, bends, nipples, and connectors shall be as manufactured by Ocal, Perma-Cote, Rob-Roy, or equal.
E. **Rigid Stainless Steel (RSS) Conduit**

1. RSS conduit, couplings, elbows, bends, and nipples shall be in accordance with ANSI C80.1 and UL 6A, and shall be constructed of Type 304 stainless steel.

2. RSS conduit ends shall be threaded. A threaded coupling shall be furnished with each length of conduit. Color-coded end caps shall be provided to protect conduit threads. Thread-less fittings are not acceptable.

3. All conduit cut ends shall be reamed or otherwise finished to remove rough edges. Where conduit is threaded in the field, a standard cutting die with tapered threads (3/4-in. taper per foot) shall be used. Running threads are not acceptable.

4. Conduit, couplings, elbows, bends, and nipples shall be as manufactured by Allied Tube & Conduit, Conduit Pipe Products Company, or equal.

2.06 **NONMETALLIC CONDUITS**

A. Nonmetallic conduit, elbows, and couplings shall be constructed of high impact, extruded, rigid polyvinyl chloride (PVC) resin. Nonmetallic conduit and fittings shall be heavy wall, Rigid Schedule 40 or Schedule 80 PVC, and rated of 90 degree C conductors. Conduit shall conform to UL 651, and NEMA TC-2, and shall be listed for underground applications encased in concrete or direct bury. PVC material shall be sunlight resistant.

B. PVC conduit shall be manufactured with integral bell ends for solvent cement welding. Each length of conduit shall bear the manufacturer’s name and UL label. Minimum conduit size shall be 3/4", unless noted otherwise.

C. Conduit fittings shall conform to NEMA TC-3, and shall be of the same material and strength characteristics as the conduit. Unless specified otherwise, elbows shall be long radius sweeps meeting the requirements of the NEC. Conduit fittings shall be provided with plain ends or bell ends for solvent cement welding.

D. Conduit, elbows, and couplings shall be as manufactured by Carlon, JM Eagle, or equal.
2.07 LIQUID-TIGHT FLEXIBLE METAL CONDUITS

A. Liquid-tight flexible metal conduit shall be in accordance with UL 360 and NEC Article 350. Liquid-tight flexible metal conduit shall be constructed of continuously interlocked hot dipped zinc galvanized steel core covered by a sunlight resistant and flame retardant thermoplastic gray PVC jacket that resists heat, oil, and chemical breakdown. Liquid-tight flexible metal conduit shall be approved for both exposed and concealed locations, and shall be rated for temperature ranges of -4 to 140°F.

B. Conduits, 1-1/4 inch and smaller, shall have an internal copper bonding conductor wound spirally in the space between each convolution.

C. Unjacketed or non-metallic flexible conduit is not acceptable.

D. Liquid-tight flexible metal conduit shall be as manufactured by Anaconda, Electri-Flex, or equal.

2.08 CONDUIT FITTINGS

Conduit fittings shall include hub, liquid-tight connectors, unions, reducers, and plugs as specified herein.

A. Materials

1. Conduit fittings shall be constructed of malleable iron, aluminum, or stainless steel. Materials provided shall be consistent with the conduit material being used (i.e. malleable iron with RSG conduit, aluminum with RA conduit, and stainless steel with RSS conduit).

2. Where PVC coated conduit systems are specified, all conduit fittings shall be PVC coated.

B. Hubs for Rigid Metal Conduits

1. Threaded conduit hubs shall be provided for all conduit connections to enclosures without integral hubs. Each hub shall be furnished with a captive o-ring gasket, insulated throat, and vibration-proof nut equipped with a grounding screw. Machined serrations on hub and nut shall bite into the enclosure assuring a tight, vibration-proof connection.
2. Hubs shall be rated NEMA Type 2, 3, 3R, 4, 4X and 12. Hubs shall be certified for NEC, Class I, Division 2, and Class II, Divisions 1 and 2 hazardous locations.

3. Hubs shall be Crouse-Hinds Types STG, STAG, SSTG, or equal.

C. Connectors for Liquid-Tight Flexible Metal Conduits

1. Connector bodies shall be straight, 45° angle, and 90° angle, as required for the installation conditions. Each connector shall be furnished with an insulated throat, gland nut, ferrule, gland nut sealing ring, sealing gasket and locknut. Connectors shall seal out water, oil, dust, and dirt. Connectors shall match conduit type.

2. Connectors shall be certified for NEC, Class I, Division 2, and Class II, Divisions 1 and 2 hazardous locations.

3. Connectors shall be Crouse-Hinds Types LTB, LT-SA, or equal.

D. Unions

1. Union shall be provided, as required, for conduit connections to threaded outlet bodies, boxes, and equipment, and for connecting two rigid conduits together. Unions shall be male, female, or male and female depending upon application.

2. Unions shall be constructed of cast gray iron, or copper-free aluminum, consistent with conduit material being used.

3. Unions constructed of gray iron shall have finish of zinc plating and aluminum acrylic paint. Unions constructed of copper-free aluminum shall be protected with an epoxy powder coat finish.

4. Unions shall be Crouse Hinds UNY, UNF, UNL, UNA, or equal.

E. Reducers and Plugs

1. Reducers shall be used to reduce conduit hubs to the next smaller size and to connect to different sizes of threaded conduit. Plugs shall be used to close threaded conduit hubs.

2. Reducers shall be constructed of machined steel, cast gray iron, or cast malleable iron. Plugs shall be constructed of machined steel, cast gray
iron, or copper-free aluminum, consistent with conduit material being used.

3. Reducers and plugs shall have external NPT tapered threads with a minimum of five threads.

4. Reducers and plugs constructed of ferrous metal shall have a finish of zinc plating with aluminum acrylic paint. Plugs constructed of copper-free aluminum shall be protected with an epoxy powder coat finish.

5. Reducers and plugs shall be Crouse Hinds RE, REC, PLG, or equal.

2.09 CONDUIT OUTLET BODIES AND OUTLET BOXES

A. Conduit outlet bodies and outlet boxes shall be in accordance with UL 514A, UL 514B, and Fed Spec W-C-586. Conduit outlet bodies and outlet boxes shall be constructed for applications in accordance with the National Electrical Code Article 314.

B. Conduit outlet bodies shall be furnished in conduit systems to: connect conduit sections, make 90° bends in conduit runs, provide pull outlets when conductors are being installed, and provide openings for making splices in conductors. Conduit outlet boxes shall be furnished in conduit systems to: act as junction boxes, act as pull outlets, accept round base wiring devices and covers, and mount lighting fixtures.

C. Conduit bodies and boxes shall be provided with threaded hubs and tapered NPT threads. Conduit bodies and boxes shall have an integral bushing to protect wire insulation. Conduit bodies shall be provided with an internal PTFE coating for easier wire pulling. Conduit bodies and boxes shall be provided with covers and neoprene gaskets and shall be weather-proof.

D. Conduit bodies and boxes shall be constructed of gray iron, copper-free aluminum, or stainless steel, consistent with the conduit material being used, unless indicated otherwise on the Drawings. Covers for conduit bodies and boxes shall be constructed of the same material as the main body.

E. Conduit bodies and boxes constructed of gray iron shall be protected with a finish of zinc plating and epoxy powder coating. Conduit bodies constructed of copper-free aluminum shall be protected with an epoxy powder coat finish.

F. Where conduit bodies and boxes are connected to PVC-coated conduit, bodies shall receive the same preparation and PVC-coating as the conduit.
G. Conduit bodies and boxes constructed of stainless steel shall be made from Type 316 stainless steel investment casting. Covers shall be stamped from Type 316 stainless steel. Screws and sealing washers shall be constructed of Type 18-8 stainless steel. Gaskets and retainers shall be constructed of neoprene rubber. Stainless steel conduit bodies shall be approved for use in wet locations.

H. Conduit outlet bodies shall be Form 7 or Form 8, as manufactured by Crouse-Hinds, or equal. Conduit outlet boxes shall be Crouse-Hinds GRFX or VXF, or equal.

2.10 EXPLOSION-PROOF CONDUIT COMPONENTS

A. General

1. All conduit outlet bodies, boxes, sealing fittings, flexible couplings, elbows, reducers, plugs, and unions provided for use in hazardous locations as defined in the NEC, shall be explosion-proof and dust ignition-proof.

2. All products shall be approved for use in Class I, Divisions 1 and 2, Groups A, B, C, and D, and Class II, Divisions 1 and 2, Groups E, F, and G locations.

3. Explosion-proof products shall be UL Listed to UL 886.

4. Explosion-proof products used in outdoor or wet locations, shall be rain-tight and water-tight.

5. Where explosion-proof products are connected to PVC-coated conduit or used in a PVC-coated conduit system, products shall receive the same preparation and PVC-coating as the conduit.

B. Conduit Outlet Bodies and Outlet Boxes

1. Conduit outlet bodies and outlet boxes shall be used for pulling wire, changing direction of conduit, providing access for splicing wires and maintenance, and interconnecting lengths of threaded conduit.

2. Conduit outlet bodies and outlet boxes shall be constructed of gray iron or copper-free aluminum, consistent with the conduit material being used, unless indicated otherwise on the Drawings.
3. Conduit bodies and boxes shall be provided with threaded hubs and tapered NPT threads. Conduit bodies and boxes shall have an integral stop bushing to protect wire insulation and shall be provided with an internal PTFE coating for easier wire pulling. Conduit bodies and boxes shall be provided with covers and neoprene gaskets. Conduit boxes shall be provided with screw on covers for easy access.

4. Gray iron conduit bodies and boxes shall be provided with covers constructed of gray iron. Conduit bodies, boxes, and covers constructed of gray iron shall be protected with a finish of zinc plating and epoxy powder coating.

5. Conduit bodies and boxes constructed of copper-free aluminum shall be protected with an epoxy powder coat finish.

6. Conduit outlet bodies and outlet boxes shall be Crouse Hinds LBH, LBY, EKC, GUA, EAB, EAJ, GUJU, and OE, or equal.

C. Sealing Fittings

1. Sealing fittings shall be provided to restrict the passage of gases, vapors, or flames from one electrical installation to another through the conduit system.

2. Sealing fittings and plugs shall be constructed of gray iron or copper-free aluminum, consistent with the conduit material being used, unless indicated otherwise on the Drawings. Sealing fittings shall be weatherproof and suitable for outdoor exposure.

3. Sealing fittings and plugs constructed of gray iron shall be protected with a finish of zinc plating and epoxy powder coating or aluminum acrylic coating. Sealing fittings and plugs constructed of copper-free aluminum shall be protected with an epoxy powder coat finish.

4. Sealing compound shall be installed in all seal fittings and shall be UL listed, non-shrinking, and resistant to water, oil, and acids. Packing fiber shall be installed to form a positive dam to hold the sealing compound. Packing fiber shall be made from non-asbestos material. Sealing compound and packing fiber shall be provided by the same manufacturer as the sealing fittings.
5. Conduit sealing fittings shall be suitable for installation in the vertical and horizontal position. Conduit sealing fittings shall be Crouse-Hinds EYS, EZS, or equal.

D. Flexible Couplings

1. Flexible couplings shall be used to connect conduit to stationary equipment that vibrates or moves due to changes in temperature or pressure, and to achieve tight bends.

2. Flexible couplings shall have a flexible inner core and outer braided covering attached to NPT tapered threaded fittings. Flexible inner core, outer braided covering and end fittings shall be constructed of stainless steel. The metallic braid and fittings shall be provided completely factory assembled.

3. For severely corrosive locations, couplings shall be furnished with a flexible PVC protective coating.

4. Flexible couplings shall be Crouse-Hinds ECGJH, ECLK, or equal.

E. Elbows, Reducers, Plugs, and Unions

1. Elbows, reducers, plugs, and unions shall be constructed of machined steel, cast gray iron or copper-free aluminum, consistent with the conduit material being used, unless indicated otherwise on the Drawings.

2. Elbows shall be threaded and shall be used to change direction of conduit by 45° or 90°, or when terminating at a box or fitting. Elbows shall be male, female, or male and female depending upon application.

3. Reducers shall be used to reduce conduit hubs to the next smaller size and to connect to different sizes of threaded conduit. Plugs shall be used to close threaded conduit hubs. Reducers and plugs shall have external NPT tapered threads with a minimum of five threads.

4. Unions (three-piece couplings) shall be provided, as required, for conduit connections to threaded outlet bodies, boxes, and equipment, and for connecting two steel conduits together. Unions shall be male, female, or male and female depending upon application.

5. Elbows, plugs, and unions shall be constructed of machined steel, cast gray iron, or copper-free aluminum, consistent with conduit material
being used, unless indicated otherwise on the Drawings. Reducers shall be constructed of machined steel, cast gray iron, or cast malleable iron.

6. Elbows, reducers, plugs, and unions constructed ferrous metal shall have finish of zinc plating and epoxy powder coating or aluminum acrylic coating. Elbows, reducers, plugs, and unions constructed of copper-free aluminum shall be protected with an epoxy powder coat finish.

7. Elbows, reducers, plugs, and unions shall be Crouse Hinds EL, RE, REC, REA, PLG, UNY, UNF, UNL, or equal.

2.11 DEVICE BOXES AND COVER PLATES

A. General Purpose Device Boxes - Indoors or Outdoors

1. Device boxes shall be in accordance with UL 514 and ANSI C33.84, and shall be constructed of cast gray iron or copper-free aluminum, consistent with the conduit material being used, unless indicated otherwise on the Drawings. Device boxes shall be weatherproof and suitable for outdoor exposure.

2. Device boxes shall be deep-type, minimum single gang size with threaded hubs, internal ground screw, and neoprene gasket for device cover plate. Device boxes shall be properly sized for the required devices or splicing. Surface mounted boxes shall be provided with integral mounting lugs.

3. Gray iron device boxes shall be provided with a hot dipped galvanized finish. Aluminum device boxes shall be provided with an epoxy powder coat finish (internal and external). Where device boxes are connected to PVC-coated conduit, boxes shall receive the same preparation and PVC-coating as the conduit.

4. Device boxes shall be Crouse-Hinds FD, Appleton FD, or equal.

B. Type 316 Stainless Steel Device Boxes

Where indicated on the Drawings, device boxes shall be constructed of Type 316 stainless steel, minimum single gang size, deep-type, with gasket and Type 316 stainless steel solid cover. Device boxes shall be properly sized for required circuitry or splicing. Surface mounted boxes shall be furnished with mounting lugs or feet. Device boxes shall be NEMA Type 4X, UL listed, and as manufactured by Wiegmann, or equal.
C. Pressed Steel Device Boxes

Device boxes may be constructed of pressed steel in lieu of cast gray iron or aluminum boxes where device boxes are required to be concealed, as indicated on the Drawings. Concealed device boxes shall be recessed in masonry or concrete walls, steel or wood stud walls, and concrete ceilings. Pressed steel device boxes shall be constructed of pre-galvanized steel, 0.062" minimum thickness. Metallic brackets shall be pre-galvanized steel or zinc plated cold roll spring steel. Pressed steel device boxes shall be provided with standard trade size knockouts to support attachment of conduit. Boxes shall be provided with a tapped hole at the bottom for attaching a ground screw. Boxes shall be deep-type and furnished with extensions as necessary for flush mounting of cover plates with the finished wall or ceiling surface. Pressed steel device boxes shall be UL listed, and as manufactured by Thomas & Betts, or equal.

D. Cover Plates

Unless indicated otherwise on the Drawings, cover plates for device boxes shall be as specified herein. Cover plates for device boxes containing toggle switches or receptacles shall be configured to match the mounted device. Cover plates for device boxes containing wiring splices shall be solid.

1. General Purpose - Indoors

Cover plates shall be stainless steel Type 302/304, standard size, smooth finish without grain, and be attached with slotted stainless steel screws. Stainless steel cover plates shall be manufactured by Hubbell, Cooper, or equal.

2. Damp Locations

Cover plates installed in damp locations shall be gasketed cast metal (matching the device box), self-closing, weatherproof cover plates. Weatherproof cover plates shall be manufactured by Hubbell, Cooper, or equal.

3. Outdoor and Wet Locations

Cover plates installed in outdoor and wet locations shall be gasketed cast aluminum, weatherproof, extra duty rated, in use type cover plates. Weatherproof extra duty in use cover plates shall be manufactured by Legrand, Thomas & Betts, or equal.
4. PVC Coating Conduit Systems

Unless indicated otherwise on the Drawings, cover plates installed in PVC coated conduit systems shall be gasketed, cast metal, PVC coated and be manufactured by the same manufacturer as the PVC coated conduit. PVC coated cover plates shall be manufactured by Ocal, Perma-Cote, or equal.

2.12 JUNCTION BOXES

A. General Purpose - Indoors or Outdoors

1. Unless indicated otherwise on the Drawings, junction boxes shall be rated NEMA 4 where located indoors or outdoors. NEMA 3R junction boxes are not acceptable.

2. Junction boxes shall be properly sized for the number and sizes of conductors and conduit entering the box and required splicing or termination. Junction boxes shall be a minimum size of 4" x 4" x 3".

3. NEMA 4 junction boxes shall be constructed of gray iron or sheet metal. PVC junction boxes are not acceptable.

4. Gray iron junction boxes shall be provided with gasketed screw-on covers and shall be hot dipped galvanized. Junction boxes shall be provided with feet where necessary for surface mounting. Gray iron junction boxes shall be Crouse-Hinds WAB, Appleton RS, or equal.

5. Sheet metal junction boxes shall be constructed of 14 gauge minimum sheet steel and shall be galvanized after fabrication and provided with a wash and phosphate undercoat, and ANSI 61 gray acrylic electrocoat finish. Sheet metal junction boxes shall be provided with tabs where necessary for surface mounting. Sheet metal junction boxes shall be provided with gasketed, continuous hinged solid doors and padlockable door hasps. Sheet metal junction boxes shall be as manufactured by Hoffman, Wiegmann, Cooper B-Line, or equal.

B. Wet or Corrosive Locations

1. Unless indicated otherwise on the Drawings, junction boxes shall be rated NEMA 4X where located in wet or corrosive locations. Junction boxes shall be properly sized for the number and sizes of conductors and conduit entering the box and required splicing or termination. Junction boxes shall be a minimum size of 4" x 4" x 3".
2. NEMA 4X junction boxes shall be constructed of Type 316 stainless steel, and provided with gasketed, continuous hinged solid doors and padlockable door hasps. PVC junction boxes are not acceptable.

3. NEMA 4X junction boxes shall be manufactured by Hoffman, Wiegmann, or equal.

2.13 METAL WIREWAYS

A. General

1. Metal wireways shall be UL listed, with NEMA ratings and sizes as indicated on the Drawings, and shall conform to the requirements specified herein.

2. Metal wireways straight sections shall be 4" wide x 4" high (minimum).

3. Wireway fittings and accessories shall conform to straight section width and height.

4. Direction and size changes shall be completed through the use of pre-fabricated fittings provided by the wireway manufacturer.

5. Metal wireways shall be manufactured by Hoffman, Cooper B-Line, or equal.

B. Indoor Locations

1. Unless indicated otherwise on the Drawings, wireways shall be rated NEMA 12 where located indoors.

2. NEMA 12 wireways shall be "lay-in" type and shall be provided with bodies and covers fabricated from 14 gauge galvannealed steel. Flanges shall be constructed of 10 gauge galvannealed steel. Covers shall be secured to the wireway and fitting body with heavy duty butt hinges and quick release latches. Covers and flanges shall be provided with oil-resistant gaskets. All covers and sealing plates shall be hinged completely open or removed to allow for continuous "lay-in" cable feed.

3. NEMA 12 wireway systems shall be provided with a wash and phosphate undercoat, and an ANSI 61 gray polyester powder finish.
C. **Outdoor or Corrosive Locations**

1. Unless indicated otherwise on the Drawings, wireways shall be rated NEMA 4X where located outdoors or in corrosive areas.

2. NEMA 4X wireways shall be "feed-through" type and shall be provided with bodies and covers fabricated from 14 gauge Type 304 stainless steel. Flanges shall be constructed of 10 gauge stainless steel. Covers shall be secured to the wireway body with heavy duty hinges on one side and screw clamps mounted on the opposite side. Covers and flanges shall be provided with oil-resistant gaskets. Outer surface of wireway body, cover, and fittings shall be provided with a smooth brushed finish.

### 2.14 NON-METALLIC WIREWAY

A. **General**

1. Non-metallic wireway shall be solid bottom type construction with minimum wall thickness of 0.1875". Covers and cover splice plates shall be snap-on type construction requiring no installation fasteners.

2. The wireway system shall conform to the applicable sections of NEC Article 362.

3. The non-metallic wireway system shall be as manufactured by Enduro Composite Systems, Inc., or equal.

B. **Construction**

1. Wireways, covers, and connector plates shall be pultruded utilizing polyester resin with UV light inhibiting additives and exterior nexus veil coverage.

2. All composite material shall meet ASTM E84, maximum 25 flame spread rating.

3. All cut ends and drilled holes (factory and field) shall be sealed with resin coating.
C. Connections, Accessories, and Supports

1. Connector plates shall be fiberglass and designed to transfer wireway loads to the support system. Fasteners for connector plates shall be Type 316 stainless steel or FRP studs and hex nuts as required.

2. Wireways shall be provided with fiberglass flat snap-on/snap-off covers.

3. Wireway support systems shall be constructed of polyester or vinyl ester resin strut channels (single or double channel as necessary) and appurtenances. Support spacing shall be in accordance with the wireway manufacturer's printed recommendations for the specified loads.

2.15 RECEPTACLES AND SWITCHES

Receptacles and switches shall be specification grade, heavy duty and provided in cast metal boxes with gasketed covers as identified and located on the Drawings. Unless otherwise indicated, the device phenolic color shall be ivory for all receptacles and toggle switches

A. General Purpose Convenience Receptacles

General purpose convenience receptacles shall be duplex, 3-wire grounding type, weather resistant, rated 125 /250 volt, AC, rated 20 amp minimum, NEMA 5-20R, and equipped with double sided screw terminals for copper wire. Convenience receptacles shall be as manufactured by Hubbell, Pass & Seymour, or equal.

B. Ground Fault Interrupter (GFI) Receptacles

GFI receptacles shall be duplex, weather resistant, NEMA 5-20R configured, ivory in color, and shall mount in a standard device box. Units shall trip at 5 mA of ground current and shall comply with NEMA WD-1-1.10 and UL 943. GFI receptacles shall be capable of individual protection as well as downstream protection, as manufactured by Hubbell, Pass & Seymour, or equal.

C. Toggle Switches

Local single pole switches shall be flush tumbler type AC rated, quiet type, heavy duty, rated 20 amp minimum, rated 120/277 volt, equipped with side screw terminals for copper wire. Switches shall conform to NEMA WD-1 Specifications. Two pole, three-way and other switches shall be similar. Switches shall be as manufactured by Hubbell, Pass & Seymour, or equal.
2.16 PILOT DEVICES AND LOCAL CONTROL STATIONS

A. Pilot Devices

1. Pilot devices consisting of oiltight/watertight push buttons, selector switches, pilot lights, and incidental items shall be as manufactured by Allen-Bradley, Eaton/Cutler Hammer, or Schneider/Square D (no substitutes).

2. Pilot devices shall be heavy duty, suitable for mounting in control stations or on control panels, and other electrical equipment.
   a. Pilot devices shall be 30.5 mm, NEMA Type 4/13 with cast metal bases, chrome-plated octagonal mounting nuts, and legend plates.
   b. Push buttons and switch knobs shall be heavy duty plastic. Pilot light lenses shall be shatter resistant plastic. Lens color shall be as indicated on the Drawings.
   c. Contact blocks shall have AC contact ratings of NEMA A600, 10 A with silver contacts for corrosion resistance and clear side plates for contact inspection.
   d. Pilot light devices shall be push-to-test type and shall be provided with LEDs and transformers suitable for operation on 120 VAC power.

B. Local Control Stations

1. Local control stations shall consist of various pilot devices mounted in a device box and located as shown on the Drawings. Pilot devices and control wiring shall be as indicated on the Drawings. Pilot devices (e.g. selector switches, pilot lights, and push buttons) shall be in accordance with the requirements specified herein.

2. Local control station device boxes shall be as specified herein and shall have the following NEMA ratings, unless indicated otherwise on the Drawings:
   a. Non-Hazardous Indoor Locations NEMA 12
b. Hazardous Indoor Locations NEMA 7

c. Outdoor Locations NEMA 4X

d. Hazardous Outdoor Locations NEMA 4 and NEMA 7

Local control station enclosures shall be of adequate size to contain the specified pilot devices, wiring, and components.

3. Local control stations shall be provided with nameplates inscribed with the name of the equipment being controlled and the control station name (e.g. Pump No. 1, Lock-Out-Stop). In addition, each pilot device shall be provided with an integral legend plate, inscribed with the function of the respective pilot device.

4. Mechanical "Lock-Out-Stop" devices where installed on pilot device "Stop" push buttons shall be constructed of stainless steel, and shall be suitable for padlocking in the "Stop" position. Mechanical "Lock-Out-Stop" devices shall be manufactured by the same manufacturer as the push button.

2.17 PANELBOARDS

Panelboards shall be factory assembled, metal enclosed, gasketed, bolted dead front and equipped with thermal-magnetic molded case circuit breakers as shown on the Drawings and as specified in Specification Section 16485, Motor Control Centers, Switchboards, and Panelboards.

2.18 OVERCURRENT PROTECTION

Circuit breakers, fuses, relays and other protective devices that protect conductors and equipment against overload currents and short circuit currents shall be provided as indicated, specified and required. Overcurrent protection devices are specified in Specification Section 16485, Motor Control Centers, Switchboards, and Panelboards.

2.19 DISCONNECT SWITCHES

Provide fusible disconnect switches, or non-fusible disconnect switches, as indicated on the Drawings and as specified herein.

A. Switches shall be steel enclosed, heavy duty, 2-pole 250 VAC or 3-pole 600 VAC, fusible or non-fusible, as indicated on the Drawings and specified herein. Disconnect switches shall be UL listed and conform to NEMA KS1. Disconnect
switches shall be as manufactured by Eaton/Cutler-Hammer, Schneider/Square D, or equal.

B. The operating mechanism shall be spring driven, with quick-make, quick-break action. Switch contact shall be knife-blade and jaw construction, with visible blades.

C. Operating handles shall be flange mounted as an integral part of the operating mechanism. The operating handle shall clearly indicate the "On" and "Off" position, and shall have provisions for padlocking with up to three (3) 3/8 inch padlocks.

D. Switches shall incorporate safety cover interlocks to prevent opening the hinged cover with the switch in the "On" position or prevent closing the switch mechanism and placing the switch in the "On" position with the hinged cover open. Provide a defeater for authorized personnel.

E. Each switch shall be provided with a factory installed equipment grounding kit and fuse puller kit.

F. Switches shall be provided with metal enclosures having the following NEMA ratings, unless indicated otherwise on the Drawings

1. Non-hazardous Indoor Locations NEMA 12
2. Hazardous Indoor Locations NEMA 7
3. Outdoor Locations NEMA 4X (Type 316 stainless steel)
4. Hazardous Outdoor Locations NEMA 4 and NEMA 7

G. Non-fusible switches shall have a minimum short circuit current rating of 10,000 A, when used in conjunction with a circuit breaker of any brand.

H. Fusible switch units shall be equipped with all required mounting brackets and guides. Unless specified otherwise, fusible switches with 30 A through 600 A frames shall be provided with rejection Class "R" type fuse clips. Unless specified otherwise, fusible switches with 800 A through 1200 A frames shall be provided with Class L type fuse clips. Fusible switches and fuses shall have a minimum short circuit current rating of 200,000 A.

All fuses shall be provided by the manufacturer. Contractor shall confirm fuse type. Contractor shall coordinate with manufacturer, including supplying
manufacturer with data on actual equipment to be furnished and results of short
circuit coordination study.

I. Switches shall be provided with a phenolic nameplate on the hinged cover that
identifies the load.

2.20 SUPPORTS

Contractor shall provide strut channels, fittings, stanchions, clamps, hangers, and
required hardware to support all conduit and equipment, as shown on the Drawings and
specified herein, and as required. Refer also to earthquake restraint provisions of
Section 11005.

A. Strut Channel Supports

1. Unless indicated otherwise on the Drawings, strut channel shall be single
strut type, 1-5/8" x 1-5/8", 12 gauge hot dipped galvanized steel with
9/16" diameter bolt holes on 1-7/8" centers.

2. Where indicated on the Drawings, strut channel shall be single strut type,
1-5/8" x 1-5/8", heavy duty, fiberglass (vinylester) with 1" x 7/16" bolt
holes on 2" centers.

3. Where indicated on the Drawings, strut channel shall be single strut type,
1-5/8" x 1-5/8", stainless steel with 9/16" bolt holes on 1-7/8" centers.
Unless specified otherwise, stainless steel strut channel shall be
constructed of Type 316 stainless steel.

4. Where indicated on the Drawings, strut channel shall be single strut type,
1-5/8" x 1-5/8", 12 gauge, PVC coated pre-galvanized steel, with 9/16"
bolt holes on 1-7/8" centers. PVC coating shall be as specified herein for
PVC coat rigid metal conduit.

5. Deep strut or double strut channel shall be provided where required for
the support load or configuration.

6. Strut channel supports shall be furnished with all fittings required for a
particular support configuration, including: conduit clamps, flat plate
fittings, angle fittings, 90° fittings, brace fittings, zee fittings, "U" fittings,
wing fittings, and post bases.

7. Strut channel fittings and fasteners shall be fabricated from the same
material and receive the same coating, as specified for the strut channel.
8. Strut channels, fittings, and fasteners shall be as manufactured by Power-Strut, Unistrut, or equal.

B. One-Hole Clamps

Clamps shall be malleable iron, hot dipped galvanized, and equipped with clamp-backs. Clamps shall be as manufactured by Crouse-Hinds, Thomas & Betts, Appleton, or equal.

C. Beam Clamps

Clamps shall be malleable iron, hot dipped galvanized, right angle and parallel types. Clamps shall be as manufactured by Crouse-Hinds, Thomas & Betts, Appleton, or equal.

D. U-Bolts

U-bolts shall be heavy-duty steel, electro-galvanized and equipped with two hex steel nuts. U-bolts shall be as manufactured Crouse-Hinds, Efcor, Kindorf, or equal.

E. Conduit Hangers

Conduit hangers shall be heavy gauge formed steel, galvanized and equipped with carriage bolts, 1/4-inch (minimum) rods and nuts. Conduit hangers shall be as manufactured by Kindorf, Appleton, or equal.

F. Lighting Fixture Hangers

Fixture hangers shall be cast iron alloy, cushion type, and equipped with outlet body and cover for fixture wiring. Fixture hanger shall permit the fixture to swing 20° from perpendicular in any direction. Fixture hangers shall be Crouse-Hinds Type ALT, Appleton Type ALT, or equal.

G. Fasteners and Anchors

1. Fasteners and anchors shall be provided to securely mount all equipment and materials.

2. Unless specified otherwise, all fasteners and anchors shall be constructed of Type 304 stainless steel.
3. Stainless steel anchors shall be provided for securing equipment and supports to masonry and concrete walls, concrete foundations, and concrete floors. Stainless steel anchors shall be wedge anchors, sleeve anchors, or epoxy anchors, as manufactured by Red Head, Hilti, or equal.

H. Spacers

Spacers shall be provided to support underground conduits for concrete encasements. Spacers shall be modular, interlocking, and constructed of high impact plastic with sufficient strength to support multiple layers of conduit. Spacers shall be as manufactured by Carlon, JM Eagle, or equal.

2.21 GROUNDING

A. Grounding and grounding components shall comply with the applicable requirements of the NEC, Article 250.

B. Grounding conductors shall be stranded copper and shall be sized in accordance with NEC requirements when sizes are not indicated on the Drawings.

C. Grounding rods shall conform to ANSI/UL 467 and shall be copper-clad steel, 3/4" (minimum) in diameter and 10' (minimum) in length. Rods shall be driven in the ground at least 9'-6" deep.

Provide the number of rods required to obtain proper ground resistance, as applicable to all service entrances, transformers, building/structure ground rings, manholes, pull boxes, etc.

D. All grounding connections of copper to copper and copper to steel of #8 AWG and larger sized conductors shall be exothermic welded connections (Cadweld). Exothermic welded connections shall create a non-removable fusion of copper grounding conductors and high conductivity copper content alloy connecting sleeves. Exothermic welding systems shall be manufactured by Erico, Furseweld, or equal.

E. All grounding connections to equipment shall use bolted lugs. When the conductor is #8 AWG and larger, the lug shall be joined to the conductor by the Cadweld exothermic weld process.

When the conductor is smaller than #8 AWG, the lug shall be joined by compression connectors manufactured from pure wrought copper. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision. The connectors shall be clearly marked with the manufacturer
and conductor size. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors. Each connector shall be factory filled with an oxide-inhibiting compound.

Screwed or bolted clamp style grounding connectors are not acceptable.

F. Solid State Decouplers shall be UL listed for grounding electrical equipment. Units shall be enclosed in fiberglass housing and be rated for an AC fault current of 1.2 kA. Solid State Decouplers shall be manufactured by Dairyland Industries.

2.22 MANHOLES AND PULL BOXES

A. Manholes and pull boxes shall be of precast concrete, designed for H-20 traffic loading. Concrete sections shall be modular with tongue and groove joints. A continuous waterproof gasket shall be provided at all section and slab joints. Manholes and pull boxes shall be equipped with galvanized steel pulling irons opposite each duct bank entrance. Manholes and pull boxes shall be provided with a sump opening and 1" ground rod opening in the base section. Sump openings shall be provided with cast iron perforated covers.

B. Unless indicated otherwise on the Drawings, manhole covers shall be cast iron, 30" round (minimum), and supported on the necking section. Pull box covers shall be hot dipped galvanized checkered plate steel, and shall be bolted down to cast-in hot dipped galvanized steel frames with stainless steel hardware. Unless noted otherwise, manhole and pull box covers shall be designed for H-20 traffic loading and shall be marked with raised lettering according to their contents (e.g. "480V Power", "Control & Instrumentation"). Cover markings shall be confirmed with the District prior to fabrication.

C. Manholes and pull boxes shall be provided with slotted galvanized steel channel inserts cast-in interior walls for conductor/cable supports. Sufficient inserts shall be provided to allow support of conductors/cables at 3-foot (maximum) intervals.

D. Manholes and pull boxes shall be provided with knockouts for connections to all underground conduit and duct banks.

E. Manholes and pull boxes shall be manufactured by Jensen Precast, Oldcastle Precast, or equal.
2.23 NAMEPLATES

Plastic nameplates shall be provided for all electrical panels, MCCs, switchboards, panelboards, individually enclosed disconnect switches, individually enclosed circuit breakers, manual starters, control panels, control stations, junction boxes, termination enclosures, receptacles, local switches, and field instruments, unless otherwise indicated on the Drawings or specified in individual specifications for respective equipment.

All nameplates shall be NEMA ES-1, 3-ply, 1/16-inch thick, beveled and satin finished and shall be securely fastened with stainless steel drive screws or escutcheon pins. Nameplates shall be as manufactured by Brady, or equal.

A. Nameplates

The nameplates shall be laminated black plastic with 1/4-inch high (unless otherwise specified) white letters. Nameplate inscriptions shall include the identifications for the equipment and loads, and shall identify the controls on control equipment as shown on the Drawings. Nameplate inscriptions on receptacles and local switchplates shall include the panelboard number and circuit that the device is connected to, e.g., "LP A-1". Nameplates on receptacles and local switchplates shall have 3/16-inch high letters.

B. Lockout/Tagout Nameplates

Lockout/tagout nameplates shall be provided for all pumps and other mechanical equipment where multiple devices including, but not limited to: switches, circuit breakers, by-pass contactors, VFDs, solid state starters, etc., may cause the equipment to be energized. Said nameplates shall be installed over the main circuit breaker or disconnect switch which will solely remove power from the equipment and all appurtenant controls and circuitry contained in the panel negating the possibility of power being applied by another source.

The nameplate shall be laminated red plastic with 3/8-inch high (unless otherwise specified) white letters. The inscription shall read "LOCKOUT/TAGOUT LOCATION FOR ________" with a description identifying the equipment (e.g. "PUMP P-1").
### MISCELLANEOUS MATERIALS AND COMPONENTS

#### A. Conduit Tags

All conduits shall be identified with tag number. The conduit tag shall be a one-inch (1") minimum diameter Type 316 stainless steel or brass disc. The tag shall be stamped with the conduit's number for that respective conduit as indicated on the Drawings. The tag shall be attached to the conduit with a stainless steel chain or stranded mechanic wire.

#### B. Thread Lubricant

1. Thread lubricant shall be provided for all threads in metal conduit, fittings, bodies, boxes, etc. The lubricant shall prevent thread galling, inhibit corrosion and maintain grounding continuity.

2. General purpose lubricant shall be provided on any metal-to-metal threaded joint. General purpose lubricant shall be Crouse-Hinds STL, Thomas and Betts Kopr-Shield, or equal.

3. High temperature lubricant shall be provided on lighting fixture threaded joints and on threaded joints of enclosures of any heat-producing apparatus or control. The lubricant shall be effective and stable from -70 to +1800 °F. The lubricant shall be Crouse-Hinds HTL, or equal.

#### C. Conductor and Cable Pulling Lubricant

Conductor and cable lubricant shall be provided to ease the pulling of conductors and cables in conduits. The pulling lubricant shall be a high performance, temperature stable, non-staining lubricant. The pulling lubricant shall be compatible with all proposed conductor and cable jackets. Conductor and cable manufacturer approvals shall be provided upon District’s request. The pulling lubricant shall not contain wax, grease, silicone, or glycol oils. Conductor and cable pulling lubricant shall be American Polywater Corporation, "Polywater J", or equal.
PART 3 - EXECUTION

3.01 GENERAL

Contractor shall provide all conduit/conductor installations and equipment installations, including connections and interconnections, as indicated on the Drawings and specified herein, and required for complete and fully operational equipment systems.

A. Electrical Materials and Products

Installation of all electrical materials and products shall conform to the requirements of the manufacturer's specifications and installation instructions. When code requirements apply to installation of materials and equipment, the more stringent requirements, code, or manufacturer's specifications and installation instructions shall govern the work.

B. Power Supplies to Mechanical Equipment

1. An electric power supply, including conduit, any necessary junction or outlet boxes, and conductors and connections shall be furnished and installed by Contractor for each item of electric motor driven mechanical equipment.

2. Circuit breakers or fused disconnect protection shall be provided for each separate item of electric motor driven mechanical equipment shown on the Drawings, or specified in other sections of the specifications for furnished equipment.

3. Power supplies to individual items of equipment shall be terminated in a suitable outlet or junction box adjacent to the respective item of equipment, or a termination box provided by the manufacturer of the equipment. Sufficient lengths of conductor at each location shall be provided to permit connection to equipment without damaging the conductors.

C. Excavations and Backfills

Earthwork shall be performed for underground conduits, manholes, pull boxes, equipment foundations, and supports, as indicated on the Drawings and specified herein, and as specified in Division 2 of the Specifications.
D. **Concrete**

Concrete shall be provided for electrical equipment foundations, support foundations and conduit encasements, as indicated on the Drawings and specified herein, and as specified in Division 3 of the Specifications. Concrete shall be Class C, 2,000 psi red colored concrete per District Detailed Provision, Section 03300, Cast-in-Place Concrete.

E. **Painting**

Painting shall be provided for installations having unfinished surfaces as specified in Division 9 of the Specifications. Field damaged factory finishes on equipment shall be touched-up with paint that is equal in quality and color to the original factory finish.

### 3.02 CONDUCTORS AND CABLES

Unless indicated otherwise on the Drawings, conductors and cables shall be furnished and installed as specified herein.

A. **General**

1. Conductors for power feeders, lighting feeders, lighting circuits, and receptacles shall be #12 AWG minimum. Conductors for control circuits shall be #14 AWG minimum.

2. Contractor shall install conductors and cables in accordance with the manufacturer’s written instructions. Contractor shall exercise care to protect conductors and cables. Contractor shall avoid: kinking the conductors; cutting, puncturing, or scraping the insulation or jacket; contamination with oil or grease; or any other damage.

3. All conductors and cables shall be installed in conduit, cable trays, wireways, or electrical enclosures. Conductors and cables shall not be installed in conduit runs until all work is completed for each individual conduit run.

4. Apply cable pulling lubricant to ease and reduce the tension stresses when pulling conductors and cables in conduits, except when installing no-lube wire. The conductors and cables shall be free of debris (dirt, mud, etc.) before being pulled into the conduits. Manufacturers recommended pulling tensions shall not be exceeded. Proper and standard pulling techniques shall be used in pulling in the conductors and
cables. Conductors and cables shall not be pulled into the conduit using a vehicle draw or tow bar, tow ball, or non-tension devices. Tensioning devices shall have pressure gauges to indicate pulling tensions being exerted on the conductors and cables during the pulling process. Pulling tension shall be continuously monitored during the duration of pulling. Conductor insulation damage will result in the conductors not being approved for energizing. Conductors and cables not passing megger or hi-pot testing or that have insulation damage shall be replaced with new conductors and cables at no additional cost to the District. Repairing of damaged conductor or cable insulation will not be approved.

5. Conductors and cables shall not be pulled tight against bushing nor pressed heavily against enclosures.

6. To prevent loading on cable connections, where cables are installed vertically, cables shall be supported by stainless steel woven grips, Kellems, or equal. In addition, stainless steel woven grips shall be provided on all submersible cables in wet wells to support cable weight and avoid stress on cable insulation.

7. All conductors or cables in conduit, over 1 foot long, or with any bends, shall be pulled in or out simultaneously.

8. Circuit to supply electric power and control to equipment and devices are indicated on the Drawings. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Circuits shall not be combined to reduce conduit requirements unless approved by the District.

9. All field wiring to/from MCCs, VFDs, and control panels shall terminate at terminal strips in the respective panels and buckets.

10. Furnish and install conduit and conductors as shown on the Drawings, as shown on the control diagrams, and as listed on the "Schedule of Conduit and Conductors" Drawing. Contractor is advised that not all conduit and conductors are listed in the Schedule (particularly 120V lighting and receptacles) and that not all conduits and conductors listed in the Schedule are specifically labeled or called out on other Drawings.

11. Contractor is advised that interconnecting wiring within and between the lineup of MCCs, VFDs, and control panels is not specifically listed or shown on the Drawings. Contractor is directed to the control diagrams and interconnection diagrams on the approved shop drawings. Wiring
for said connections shall run within the MCC, VFD, and control panel wireways, or in conduit between MCCs, VFDs, and control panels.

12. Install continuous circuit conductors from source to load without splices or terminations in intermediate junction boxes, manholes, or pull boxes.

B. Splicing and Terminating

1. Where authorized by the District, splices may be made only at accessible locations.

2. Splicing of instrument cables and control conductors will not be allowed.

3. Conductors #10 AWG and smaller for lighting and receptacles may be spliced in junction boxes, outlet boxes, and conduit bodies. Lighting and receptacle conductors shall be spliced with tapered coil spring type connectors.

4. Stranded conductors shall be terminated by lugs or compression type connectors. The connectors shall be crimped with a tool that provides uniform and tight connections. Wrapping stranded conductors around screw type terminals is not acceptable.

5. Splices and terminations of #8 AWG and larger conductors shall be with non-insulated compression type connectors. Splices and terminations of #10 and smaller conductors shall be with pre-insulated compression type connectors. Connector voltage and amperage ratings shall be equal to, or greater than, the conductor ratings.

6. Non-insulated compression type splice connectors shall be taped with two layers of half lapped liner-less rubber splicing tape and provided with a cold shrink connector insulator sleeve (pre-slipped over the conductor) over the splice connector. Cold shrink insulators shall be as manufactured by 3M Company, or equal.

7. Control conductors shall be splice with terminated with split tongue pre-insulated, crimp type connectors.

8. Terminations in all motor terminal boxes shall be made with compression type connectors. Connections to motor leads in the motor terminal boxes shall be compression lug type with motor splice boots to serve as insulators.
9. Splices in underground manholes and pull boxes will not be allowed.

10. All conductors and cables in electrical panels, MCCs and equipment enclosures shall be neatly bundled and fastened.

C. Grounding

1. Grounding shall be provided as shown on the Drawings and in accordance with the NEC.

2. Where indicated on the Drawings, bare copper conductors shall be installed in a ground ring encircling buildings or structures in direct contact with the earth. The ground ring shall be placed under building or structure footing and be buried at a depth below the earth's surface of not less than 30". When installed beneath building foundation, provide a minimum 3" earth cover from bottom of footing.

3. Ground rods shall be installed as shown on the Drawings and specified herein. Provide additional rods as applicable to all service entrances, transformers, building/structure ground rings, manholes, pull boxes, etc. as required to obtain a maximum ground resistance of 15 ohms at each location. Ground continuity shall be maintained through all manholes and pull boxes. All metal parts in manholes and pull boxes shall be connected to the grounding system.

4. Copper to copper exothermic welded connections (Cadweld) shall be provided for connections between multiple copper grounding conductors, such as equipment ground conductors, buried ground conductors, and building/structure ground rings. Copper to steel Cadweld connections shall be provided for connections between copper grounding conductors and copper-clad steel ground rods, steel rebar mats, steel pipes, and other steel surfaces as indicated on the Drawings.

5. Where indicated on the Drawings, copper conductors not smaller than #4 AWG shall be connected to steel rebar mats of concrete slabs and building floors to supplement the grounding electrode system. Solid State Decouplers shall be installed to provide cathodic protection between the rebar mats and copper conductors.

6. Enclosures of equipment, raceways and fixtures shall be permanently and effectively grounded. A code-sized, copper, insulated green equipment ground shall be provided for all branch circuit and feeder runs. Equipment grounds shall originate at MCC ground bus and shall be
bonded to all junction boxes and electrical equipment enclosures. Similarly, equipment grounds shall originate at panelboard ground bus and shall be bonded to all switch and receptacle boxes, and electrical equipment enclosures. Ground terminals on receptacles shall be connected to the equipment grounding conductor by an insulated copper conductor.

7. All flexible conduits shall be provided with an insulated green copper ground conductor, #12 AWG, unless indicated otherwise on the Drawings.

8. Bonding conductors shall be installed between all raceways, enclosures, wireways, and cable trays.

9. Grounding bushings shall be installed on all conduit terminations, including conduit directly connected to enclosures and conduit stubbed up into block-out areas for free standing enclosures. A bonding conductor, #8 AWG minimum, shall be provided between all conduit ground bushings and enclosure ground.

10. SCE equipment grounding shall be provided and installed as required by SCE.

D. Identification

1. All conductors and cables shall be marked with wire markers at each end and at each intermediate junction box, pull box, manhole or enclosure, except for short "jumper" wires. Wire markers shall indicate the designation/destination of the conductors/cables. Example being-LPA CB1 - REC1 to indicate lighting panel A, circuit breaker #1 to receptacle #1; MCCCB4 - MTR4 indicating Motor Control Center Breaker #4 to Motor #4; etc.

2. Wire markers for conductors and cables shall be heat shrinkable identification sleeves and translucent shrink tubes, as specified herein.

3. Where more than two conductors run through a single outlet, each circuit shall be marked with the corresponding circuit number at the panelboard.

4. Conductors size #6 AWG and larger shall be color coded using specified phase color markers and shall be provided with identification markers.
5. All terminal strips shall have each individual terminal identified with printed markers.

6. All receptacles and switches shall be provided with plastic decal labels on the cover plate, denoting the lighting panel and circuit number.

### 3.03 CONDUIT MATERIAL SCHEDULE

The required conduit material(s) for the project shall be as indicated on the Drawings. In addition, Contractor shall comply with the following Conduit Material Schedule for permitted materials for various locations and uses.

<table>
<thead>
<tr>
<th>Location or Use</th>
<th>Conduits Permitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underground (not under building slabs, foundations, or</td>
<td>Concrete encased PVC conduit with PVC-RGS or PVC-RA conduit for horizontal bends,</td>
</tr>
<tr>
<td>concrete slabs on grade</td>
<td>90 degree stub ups and risers.</td>
</tr>
<tr>
<td>Under building slabs, foundations, or concrete slabs on</td>
<td>PVC with PVC-RGS or PVC-RA conduit for</td>
</tr>
<tr>
<td>grade</td>
<td>horizontal bends, 90 degree stub ups and</td>
</tr>
<tr>
<td></td>
<td>risers (see line below for concrete footing requirements)</td>
</tr>
<tr>
<td>In building concrete slab (if min. 12&quot; thick) or</td>
<td>PVC-RGS, PVC-RA conduit (min. 1&quot; clearance</td>
</tr>
<tr>
<td>concrete footings (1)</td>
<td>to all rebar)</td>
</tr>
<tr>
<td>In concrete walls or masonry walls (1)</td>
<td>PVC, PVC-RGS, PVC-RA</td>
</tr>
<tr>
<td>In steel stud or wood stud walls</td>
<td>RGS, RA</td>
</tr>
<tr>
<td>In ceiling or attic space</td>
<td>RGS, RA</td>
</tr>
<tr>
<td>Exposed outdoors</td>
<td>RGS, RA</td>
</tr>
<tr>
<td>Exposed outdoors, corrosive locations</td>
<td>PVC-RGS, PVC-RA</td>
</tr>
<tr>
<td>Exposed outdoors, hazardous locations</td>
<td>PVC-RGS, PVC-RA</td>
</tr>
<tr>
<td>Exposed indoors, dry locations</td>
<td>RGS, RA, RSS</td>
</tr>
<tr>
<td>Exposed indoors, damp or wet locations</td>
<td>PVC-RGS, PVC-RA, RSS</td>
</tr>
<tr>
<td>Exposed indoors, corrosive locations</td>
<td>PVC-RGS, PVC-RA</td>
</tr>
<tr>
<td>Exposed indoors, hazardous locations</td>
<td>PVC-RGS, PVC-RA</td>
</tr>
<tr>
<td>Exposed belowgrade, dry locations</td>
<td>RGS, RA, RSS</td>
</tr>
<tr>
<td>Exposed belowgrade, damp or wet locations</td>
<td>PVC-RGS, PVC-RA</td>
</tr>
<tr>
<td>Exposed belowgrade, sewage wet wells</td>
<td>RSS</td>
</tr>
</tbody>
</table>

(1) Conduit shall be cast in concrete or in masonry walls only where specified on the Drawings.
3.04 CONDUIT

Unless indicated otherwise on the Drawings, conduit shall be installed as specified herein.

A. General

1. Contractor shall install conduit and electrical equipment in locations that will cause minimal interference with the maintenance and removal of mechanical equipment. Conduits and connections are shown schematically on the Drawings unless specific routing is indicated thereon. Contractor shall run conduit in a neat manner parallel or perpendicular to walls and slabs, and wherever possible, installed together in parallel runs supported with strut channel support system. All conduits shall be installed plumb, straight, and true with reference to the adjacent work.

2. Contractor shall furnish and install properly sized pull boxes, junction boxes, conduit bodies (LBs), etc., wherever necessary in order that a run of conduit between conductor/cable pull points does not contain more than the equivalent of three (3) quarter (90 degree) bends (270 degrees total), or where pulling tension required would exceed the maximum allowable for the conductor/cable to be installed. Contractor shall note that all required boxes and conduit bodies are not shown on the Drawings. Boxes and conduit bodies shall be provided at locations acceptable to the District.

3. Unless indicated otherwise on the Drawings, conduits shall be concealed underground, under concrete slabs and footings, or exposed mounted on walls and ceilings. Concealed conduits shall be run in as direct a route as possible and with bends of large radii. Floor penetrations shall be made only at specific approved locations; other penetrations are prohibited.

4. Locations of conduit runs shall be planned in advance of the installation and coordinated with the electrical panel lineup furnished, ductwork, plumbing, ceiling, wall, and footing construction in the same areas. Conduits shall not unnecessarily cross other conduits or pipe, nor prevent removal of nor block access to mechanical or electrical equipment.

5. Minimum conduit size shall be 3/4". Where device or instrument connection size is 1/2", Contractor shall provide the necessary fittings for connection. Alternatively, Contractor may provide 1/2" liquid-tight flexible conduit.
6. **Belowgrade (buried) conduit shall be installed with a minimum of 27” cover, including conduit under structures and concrete slabs on grade. Where change in direction is required, long radius elbows shall be installed. Buried conduit shall be installed using approved spacers and cradles. Conduit shall be properly supported/anchored and at sufficient intervals to prevent movement during encasement operations (maximum spacing of 5’).**

Conduits shall be installed beneath concrete slabs on grade, footings, or trenches with a minimum of 6” clearance between conduit and bottom of concrete. Conduit backfill where installed beneath concrete shall be two sack sand-cement slurry from the top of concrete encasement to subgrade.

Conduit shall be cast in concrete or in masonry walls only where specified on the Drawings.

7. **Buried conduit shall be completely encased in concrete, including conduit under structures and concrete slabs on grade, and SCE conduit located on District property. Concrete shall be provided with an integral red dye coloring. Provide at least 3 inches of concrete cover from the outside of the conduits to the outside of the encasement. Top of concrete encasement shall be a minimum of 24" below grade. Backfill above concrete encasement shall be compacted to a minimum of 90% relative compaction.**

8. **Buried conduit shall be supported by modular, interlocking, plastic spacers prior to placing concrete for duct bank encasement. Spacers shall be installed in accordance with the manufacturer’s printed instructions and shall be located to maintain a uniform separation between conduits throughout the duct bank alignment.**

9. **Where power and control/instrumentation conduits are routed in the same duct bank, configure the conduits within the duct bank to provide a minimum separation of 6" between power and control/instrumentation conduits.**

10. **Prior to installation of conductors in underground conduits, a testing mandrel not less than 6" long and with a diameter 1/4" less than the conduit diameter shall be drawn through after which a stiff bristle brush of the proper size for the conduits shall be drawn through until the conduits are free of all sand and gravel.**
11. Where Schedule 40 or Schedule 80 PVC conduit is permitted, horizontal bends and vertical risers and bends shall be PVC-RGS or PVC-RA. Vertical risers and bends shall be completely encased in concrete to finished grade.

12. Where conduit is stubbed through concrete slabs or footings into electrical panels (MCCs, VFDs, switchboards, etc.), a minimum of 1-1/2" clearance shall be provided between rebar and conduit and a minimum of 1" clearance shall be provided between conduits. Adjust rebar spacing as necessary to a maximum of one-half the nominal spacing such that maximum rebar spacing does not exceed 1-1/2 times that specified. The total amount of reinforcing steel shall not be reduced.

13. Prior to installation of conduit, Contractor’s submittals for: basic electrical materials, MCCs, VFDs switchboards, panelboards, and control panels shall be accepted by the District.

14. Conduits shall terminate within the respective MCC/electrical panel section, or in adjacent section if additional space is required. Contractor shall adjust location of conduit terminations based on accepted MCC/electrical panel layout.

15. Spare conduits shall be provided with threaded plugs or caps and polyester pull line attached to the threaded plug/cap or enclosure (as applicable).

16. All conduits shall be tightly sealed during construction by use of conduit plugs or "pennies" set under bushings. All conduit in which moisture or any foreign matter has collected before pulling conductors shall be cleaned and dried to the satisfaction of the District.

17. Conduits shall be securely fastened to enclosures, cabinets, boxes, and wireways using hubs and locknuts, and an insulating bushing or specified insulated connectors.

18. All conduits shall be labeled with stainless steel or brass tags as specified herein. Tags shall be stamped with the conduit's number for that respective conduit as indicated on the Drawings. Conduit shall be labeled at both ends and at all intermediate connection points to junction boxes, wireways, pull boxes, and manholes.
Buried conduit shall be labeled within free standing panels, pull boxes, and manholes. Exposed conduit shall be labeled before they enter junction boxes, wireways, wall mounted panels, etc.

19. Aboveground and underground power feed conduits from VFDs to electric motors or from rectifiers to electrical equipment shall be PVC-RGS or PVC-RA.

20. Conduit and device boxes installed abovegrade in buildings shall be surface mounted.

21. Conduit and enclosures shall be installed with a minimum clearance of 12" to hot pipes or surfaces (150°F or higher).

22. Ground conductors shall be installed in all metallic and non-metallic conduits.

23. In addition to grounding conductors, bonding conductors shall be provided on all metallic conduits, device boxes, and enclosures.

B. Liquid-Tight Flexible Metallic Conduit

1. Liquid-tight flexible conduit shall be installed for connections to equipment including, but not limited to: motors, HVAC equipment, automatic valves, flow meters, pressure transmitters, level measurement transducers, thermocouples, and similar devices. Liquid-tight flexible conduit length shall not exceed 36" at connections to equipment.

2. Liquid-tight flexible conduit connectors and fittings installed in PVC-RGS or PVC-RA systems shall be PVC coated.

3. A separate ground conductor shall be installed in flexible conduit that does not have an internal copper bonding conductor included by the manufacturer, or where indicated on the Drawings.

4. Stainless steel braided flexible conduit (flexible couplings) rated for Class 1, Division 1 locations shall be installed in hazardous locations per NEC Article 501 requirements.

5. Liquid-tight flexible conduit will not be allowed for correcting misaligned conduit, including misaligned stub-ups beneath wall mounted panels, misaligned conduit wall penetrations, etc. Contractor shall coordinate
the location of all conduit stub-ups and wall penetrations with the actual
equipment to be furnished for the project.

C. **Rigid Non-Metallic Conduit**

1. Schedule 40 or 80 PVC conduit may be used underground where permitted. PVC conduits shall not be run exposed.

2. Ground conductors shall be installed in all non-metallic conduits.

3. Where Schedule 40 or Schedule 80 PVC conduit is permitted, all horizontal and vertical bends, and vertical risers shall be PVC-RGS or PVC-RA. All belowgrade horizontal bends and vertical bends shall be long radius elbows. Bending of straight PVC conduit to avoid installation of the specified PVC-RGS or PVC-RA long radius elbows will not be allowed.

4. Where conduit transition from nonmetallic to metallic is required, provide nonmetallic threaded adapters.

D. **Metallic Conduit (RGS and RA)**

1. All RGS and RA conduit and fittings in direct contact with the ground, concrete, or grout shall be PVC coated as specified herein. Alternatively, RGS and RA conduit may be protected by double wrapping with 20 mil polyvinyl-chloride (PVC) tape.

2. Defects and scratches on exposed RGS conduit shall be repaired with hot stick galvanizing solder, Galva-Guard, or equal.

E. **PVC Coated Metallic Conduit (PVC-RGS and PVC-RA)**

1. All device boxes, conduit bodies, cover plates, conduit straps, conduit fittings, and liquid-tight connectors installed in PVC coated metallic conduit systems shall be PVC coated.

2. Cut or damaged PVC coating shall be repaired in strict accordance with the manufacturer's written repair procedures to maintain the integrity of the 40 mil PVC coating system. Repair sprays or paint will not be acceptable.
F. Termination and Joints

1. Conduit shall be joined using specified couplings or transition couplings where dissimilar conduit systems are joined.

2. Conduit terminations at boxes enclosures and boxes shall be water-tight and dust-tight. Conduit terminations shall be made using approved gasketed connectors and hubs.

3. Expansion couplings shall be installed where any conduit crosses a building separation joint.

4. At all conduit terminations and connections to cabinets, boxes and enclosures, etc., conductors shall be protected by a fitting equipped with a plastic bushing having a smoothly rounded insulating surface.

G. Threads

1. All metal conduit cut ends shall be reamed or otherwise finished to remove rough edges.

2. Where conduit is threaded in the field, a standard cutting die with NPT tapered threads (3/4-in. taper per foot) shall be utilized to provide full cut threads. Running threads are not acceptable.

3. All male threads on metallic conduit and fittings shall be coated with a thread lubricant before installing connections. The thread lubricant shall be as specified herein. All connections shall be made watertight.

4. Any exposed threaded surface on RGS conduit shall be thoroughly cleaned with solvent to remove any residual lubricant or other contaminants, and shall then be completely coated with a zinc rich cold galvanizing coating, CRC Zinc-It Cold Galvanize, or equal.

H. Locknuts and Bushings

Locknuts and bushings shall be installed on the threads of metal conduits that enter through close-fit openings in enclosures.

I. Seal Fittings

1. Seal fittings shall be connected to rigid metal conduits in hazardous areas to prevent gases and flames from passing from one area to another.
through the conduit system. Hazardous areas shall be as defined by NEC, Article 500.

2. Seal fitting locations shall be in accordance with NEC, Article 501.

3. Unless specified otherwise, install seal fittings not less than 4 inches from finish floor or wall, but not more than 18 inches.

J. Stub-Ups

1. Unless indicated otherwise herein or on the Drawings, all indoor and outdoor conduit stub-ups shall be provided with a threaded coupling, and shall extend 2" above slab, grade, or structure.

2. Exposed conduit, stubbing up through floor slabs or slabs on grade into the bottom of exposed panels, cabinets, or equipment, shall be properly aligned and spaced for connection to same, and shall be straight and plumb. Offset rigid conduit or flexible conduit installed with an offset will not be allowed. Conduits shall be installed at sufficient depth below slab to eliminate any part of the bend above top of slab.

3. Where spare conduit is stubbed through concrete slabs adjacent to walls or equipment, conduit shall extend approximately 2" above the top of the concrete slab and shall be provided with a threaded coupling and plug.

Where spare conduit is stubbed through concrete slabs in open floor areas, conduit shall be provided with a threaded coupling and plug installed flush with the finished floor.

K. Conduit Through Roof

1. Provide a watertight seal around conduits that penetrate through the roof. Coordinate the conduit installation work with the roofing installation work in new building construction. Modify roofing as required where conduit installation is in existing buildings.

2. As a minimum, conduit penetrations shall be provided with full circumference galvanized sheet metal flashing and counterflashing integrated into the roofing system. Flashing shall be attached to the conduit with stainless steel hose clamps (2 minimum). Flashing shall be installed with roofing cement and/or sealant as necessary to provide a watertight seal.
3. Conduit penetrations through built-up roofs with metal decking shall be provided with galvanized sheet metal pitch pockets integrated into the roofing system and filled with roofing cement.

L. Duct Banks

1. Contractor shall be responsible for layout/configuration of duct banks and coordination of pull box sizes. Proposed duct bank layouts and cross sections shall be submitted to District for review prior to commencing installation. Contractor's as-built drawings shall include cross sections (drawn by Contractor) of all electrical duct banks. Said duct bank cross sections and as-built drawings shall be prepared as the project proceeds and shall be reviewed by Contractor with District at least monthly.

2. Complete as-built electrical duct bank drawings shall be submitted to District upon completion of construction.

M. Labeling

Contractor shall field number and label all conduits and provide complete as-built drawings to District. All conduits within manholes and pull boxes shall be permanently labeled therein and labeled where they stub up to an MCC, switchboard, panelboard, VFD, control panel, cabinet, or junction box. Conduits shall be labeled with brass or stainless steel tags attached to conduit with stainless steel stranded wire.

3.05 CONDUIT FITTINGS, BOXES, AND WIRING DEVICES

Conduit fittings, outlet boxes, wiring devices, and appurtenances shall be installed as indicated on the Drawings, specified herein, and required.

A. Materials

1. Conduit fittings, outlet bodies, outlet boxes, and device boxes shall be constructed of ferrous metal, aluminum, or stainless steel. Materials provided shall be consistent with the conduit material being used (i.e. ferrous metal with RSG conduit, aluminum with aluminum conduit, and stainless steel with stainless steel conduit).

2. Where PVC coated conduit systems are specified, all conduit fittings, outlet bodies, outlet boxes, and device boxes shall be PVC coated.
B. Hubs

1. Enclosures without integral hubs shall be provided with close-fit holes for conduit connections. Conduit connections shall be made with water-tight and dust-tight hubs.

2. Hubs shall be furnished with vibration-proof nuts equipped with grounding screws.

3. All hub ground nuts in an enclosure shall be bonded with a ground conductor (green insulated #12 AWG, minimum) to the enclosure ground.

C. Boxes

1. All outlet boxes and device boxes shall be surface mounted on walls, ceilings, and floors, except where indicated on the Drawings or specified herein to be concealed and finished flush.

2. Unless indicated otherwise on the Drawings, wall mounted light fixtures shall be provided with device boxes (single or double gang depending on fixture size) recessed into concrete, masonry, or gypsum covered walls. Light fixture wiring shall be spliced with lighting panelboard conductors inside the device box. Contractor shall attach the light fixture to the wall surface with and/or device box in accordance with the manufacturer’s recommendations and as necessary to provide a secure and rigid assembly. Fasteners shall be constructed of stainless steel. Outdoor light fixtures shall be installed with rubber gaskets and sealant as necessary to provide a watertight assembly.

3. Outlet boxes and device boxes specified to be finished flush in concrete, masonry, or gypsum board covered walls shall be furnished with box extensions as necessary to provide a flush finished installation for the box cover plates. Pressed steel boxes shall be wrapped with PVC tape to prevent concrete or grout from entering the box through unused holes or knockouts during placement operations.

4. Cast device boxes shall be provided for all toggle switches and receptacles.

5. No unused openings shall be left in any box. Close-up plugs shall be installed as required to seal openings.
6. Boxes in outdoor, damp, and wet locations shall be provided with gasketed, cast metal cover plates.

7. Device boxes for convenience receptacles and switches in damp locations shall be provided with self-closing, gasketed, cast metal cover plates.

8. Device boxes for convenience receptacles in outdoor and wet locations shall be provided with gasketed, cast metal, weatherproof, extra duty rated, in-use type cover plates.

D. Box Layout

1. Outlet and device boxes shall be installed at the locations and elevations shown on the Drawings or specified herein. Adjustments to locations shall be made as required by structural conditions and to suit coordination requirements of other trades. Where specified to be flush mounted on concrete masonry wall, center box in course of concrete block.

2. Unless indicated otherwise on the Drawings, device boxes for convenience receptacles shall be installed 18" above finished floor or finished grade.

3. Unless indicated otherwise on the Drawings, device boxes for toggle switches shall be installed 48" above finished floor or finished grade.

3.06 MANHOLES AND PULL BOXES

A. As a minimum, underground manholes and pull boxes shall be sized and located as indicated on the Drawings. Depending on the Contractor's duct bank routings and configurations, additional or larger manholes and pull boxes may be necessary. Manhole/pull box knockout areas shall be sized according to Contractor's duct bank configurations and dimensions. Contractor shall be responsible for coordinating manhole and pull box sizes and knockout dimensions/locations with the manufacturer. All costs for additional, larger, or custom manholes and pull boxes shall be borne by the Contractor.

B. Place bottom of manholes and pull boxes on 12" thick (minimum) graded 3/4" crushed rock compacted to 95% relative compaction. Unless noted otherwise, provide crushed rock (2' deep by 2' square) beneath each drain sump, and knock out concrete sump bottom for drainage.
C. Install a continuous waterproof gasket at all manhole and pull box section and slab joints.

D. Manholes and pull boxes shall be provided with conductor/cable supports as required to support conductors/cables at 3-foot (maximum) intervals. Supports shall be fabricated from hot dipped galvanized or fiberglass strut channel and attached to cast-in channel inserts. Provide glazed porcelain insulators with channel clamps for support channels. Strap conductors/cables to insulators with plastic tie wraps. All phase and ground conductors in each circuit shall be kept together and contained on/in the porcelain insulators. No phase conductors shall be run separate from the other two phases and ground.

E. All duct bank and conduit penetrations shall be grouted all around with non-shrink grout. Non-shrink grout shall be finished flush with the interior wall surface. All conduits shall be terminated with flush-end bells.

F. One ground rod shall be provided for each manhole and pull box. Provide a #4/0 bare stranded copper ground wire completely around the inside perimeter of each manhole and pull box, and anchor the ground wire to walls. Connect the ground wire to the ground rod. Bond the bare copper ground wire to any splice shield wires, ground wires, metal cable racks, cover frames, sump frames and other metal items in the manholes. All separate ground wires accompanying circuits shall be grounded in each manhole or pull box passed through.

3.07 PANELBOARDS

Panelboards shall be factory assembled, and shall be installed as indicated on the Drawings and specified herein.

A. Panelboards shall be installed 6 feet from grade or floor to top of the enclosure.

B. Provide at least 1/2 inch clearance between the back of the panelboard enclosure and masonry or concrete wall.

C. Securely attach the panelboard to the wall or support structure with anchor bolts or machine bolts.

D. Attach locking devices on the handles of branch circuit breakers for the "ON" position as indicated on the Drawings.

E. Completely type the directory card to identify each connected and spare circuit.

F. Provide tight connections for all feeder and branch circuit conduit and wiring.
3.08 TRANSFORMERS

A. Transformers shall be installed in accordance with manufacturer's printed instructions, including minimum clearances for ventilation and cooling. Transformers installed against a wall shall have readily accessible primary and secondary terminals.

B. Transformers shall be installed on vibration pads designed to suppress the transformer vibrations. Pads shall be selected based on the actual transformer weight and a minimum safety factor of 2:1. Vibration pads shall be located in accordance with the manufacturer's recommendations.

C. Conduit connections to the transformer shall be with liquid-tight flexible conduit.

D. During startup and testing, Contractor shall obtain primary and secondary voltage readings, and if necessary, tap connections shall be adjusted to provide the specified nominal supply voltage.

3.09 DISCONNECT SWITCHES

Disconnect switches shall be factory assembled, and shall be installed as indicated on the Drawings and specified herein.

A. Disconnect switches shall be installed 5 feet from grade or floor to the top of the enclosure.

B. Securely attach disconnect switches to walls or support structures with anchor bolts or machine bolts.

3.10 SUPPORTS

Unless indicated otherwise on the Drawings, electrical conduit, boxes, enclosures, cabinets, panels, and equipment shall be supported as specified herein.

A. Install the required strut channels, fittings, clamps, U-bolts, hangers, anchors, hangers, fittings, and other hardware to securely attach and support all the equipment and conduits. Unless indicated otherwise on the Drawings, all support materials shall be steel, malleable iron, or other ferrous metals, and shall be hot dipped galvanized after fabrication. Where indicated on the Drawings, support material shall be fiberglass, stainless steel, or PVC coated steel and malleable iron.
B. Exposed conduit shall be supported with strut channel, clamps, and hanger supports spaced per NEC requirements (8'-0" maximum spacing) and within 18" of couplings, bends, enclosures, boxes, etc.

C. Multiple conduit runs shall be supported using "trapeze" hangers, consisting of approved strut channels suspended on 3/8" (minimum) steel rods from beam clamps or ceiling inserts located not more than 8' apart. Sizes of channels and rods shall be selected as recommended by the manufacturer for span and loading conditions.

D. Unless indicated otherwise on the Drawings, Contractor shall use Type 304 stainless steel fasteners and anchors, including wedge anchors, sleeve anchors, epoxy anchors, machine bolts, etc., for mounting electrical equipment and conduit. No type of explosive anchor will be permitted.

E. Strut channel shall be neatly cut and provided with squared ends. All burrs shall be removed and sharp edges shall be rounded. Channel ends shall then be treated as follows:

1. Hot dipped galvanized strut channel - solvent clean to remove any contaminants and coat with a zinc rich cold galvanizing coating, CRC Zinc-It Cold Galvanize, or equal.

2. Fiberglass strut channel - seal with fiberglass resin in accordance with the manufacturer's recommendations.

3. PVC coated pre-galvanized strut channel - solvent clean to remove any contaminants and coat with PVC repair coating in accordance with the manufacturer's recommendations.

4. Stainless steel strut channel - no additional treatment required.

3.11 NAMEPLATES

A. Plastic nameplates shall be positioned and lined-up to provide a neat appearance. They shall be attached to the cleaned metal surfaces of enclosures with stainless steel machine screws or escutcheon pins. Nameplates shall be attached to receptacle and local switch cover plates with an adhesive or equal for circuit identification and placed above the device.

B. Nameplates shall be installed on all motor control centers, switchboards, panelboards, individually enclosed circuit breakers and disconnect switches,
control panels, control stations, junction boxes, termination cabinets, toggle switches, and convenience receptacles.

3.12 CUTTING AND REPAIRING

A. Where conduit installation requires penetrating existing concrete or masonry structures (walls, floors, or ceilings), Contractor shall core drill the existing structure and fill the remaining annular space with non-shrink grout.

B. Other demolitions methods for other cutting or removing shall be approved by the District prior to commencing the work. Contractor shall repair all damage to remaining facilities caused said demolition to the satisfaction of the District.

3.13 DISSIMILAR METALS

A. Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action.

B. Wherever dissimilar metals come in contact, Contractor shall isolate these metals as required with neoprene washers or gaskets.

C. Where fastening aluminum items, stainless steel bolts shall be used.

D. Wherever steel and aluminum join, isolation bushings shall be used to separate these dissimilar metals and grounding jumpers shall be provided across these joints.

3.14 WORKMANSHIP

A. Preparation, handling, and installation shall be in accordance with manufacturer's written instructions and technical data particular to the product specified and/or approved, except as otherwise specified.

B. Work shall be furnished and placed in coordination and cooperation with other trades.

C. Work shall conform to the National Electrical Contractors Association Standard of Installation for general installation practice.

3.15 PROTECTION DURING CONSTRUCTION

A. Conduits, junction boxes, outlet boxes, and other openings shall be kept closed to prevent entry of foreign matter.
B. Fixtures, equipment, and apparatus shall be covered and protected against dirt, paint, water, chemical or mechanical damage, before and during the construction period.

C. Damaged fixtures, apparatus, or equipment shall be restored to original condition prior to final acceptance, including restoration of damaged shop coats of paint. Brightly finished surfaces and similar items shall be protected until in service. No rust or damage will be permitted.

3.16 CHECKING, ADJUSTING AND TESTING

Provide the required labor and equipment, and all checking, adjusting and testing operations on the electrical installations.

A. Check

All wire terminals shall be checked to assure tight connections.

B. Adjust

Adjust repeat cycle timers, interval timers and time delay relays and other devices so the controls shall operate in the indicated sequence.

C. Wiring Tests

The tests shall be performed to detect wrong connections, short circuits, continuity and grounds. Insulation tests shall be made with a hand crank or battery operated test instrument on all cables, conductors and motors. Power feeders branch conductors and motors shall be tested phase-to-phase, and phase-to-ground. A copy of the test results for feeders and motors shall be submitted to the District when completed (after any deficiencies have been noted and corrected). Correct any installation and electrical defects in the wiring systems.

D. Equipment Tests

Perform equipment tests as indicated and directed by the manufacturer, and as specified in Section 16010 and other Sections of the Specifications specifying equipment and/or systems.
E. Test Data

Test data for equipment, shielded cables and supply voltage shall be submitted to the District.

F. Supply Voltage

Test the supply voltage while the normal plant loads are operating. If the voltage is not within normal limits (plus or minus one percent), notify the District.

G. Operation Tests

Perform operation tests and observe that all electrical loads operate satisfactorily as specified in Section 16010 and other Sections of the Specifications specifying equipment and/or systems.

3.17 CLEANUP

A. All parts of the electrical materials and equipment shall be left in a clean condition. Exposed parts shall be clean of cement, plaster and other materials, and all oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Paint touch-up shall be applied to all scratches on panels and cabinets. Interiors of electrical cabinets or enclosures shall be free of spider webs and shall be vacuumed clean.

B. During the progress of the work, the Contractor shall clean up after his workers and shall leave the premises and all portions of the site in which he is working free from debris and surplus materials.

END OF SECTION
SECTION 16255
AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.01 SCOPE

A. This section specifies the requirements for the design, fabrication, assembly, wiring, testing, delivery, and installation of low voltage (600 volt) automatic transfer switches (ATS). Each ATS unit shall consist of a mechanically held power transfer switch and a microprocessor controller, interconnected to provide complete automatic operation.

B. Contractor shall furnish and install ATS units with the number of poles, amperage, voltage, and withstand current ratings as specified herein and shown on the Drawings.

1.02 SPECIFIC PROJECT ATS REQUIREMENTS

This section provides specific project details regarding ATSs, which shall modify specified requirements in Part 2, herein.

A. General

Contractor shall furnish and install one (1) 100 A (minimum) ATS unit for connection to the new standby power diesel engine generator set and utility power from the County's existing equipment building, as indicated on the Drawings and specified herein.

Design Requirements

1. ATS unit shall be rated for closing and withstand ratings as specified herein for 480 VAC.

2. ATS unit shall be 3-pole with silver plated solid copper bus bars, and terminals as required for connection to power source and load side conductors as shown on the Drawings. Contractor shall coordinate connection of conduit and conductors with ATS manufacturer.

3. ATS unit enclosure shall be suitable for wall mounting, rated NEMA 4, and fabricated in accordance with UL Standard 508. Enclosure shall be polyester powder coated, gray.
1.03 RELATED SECTIONS

A. The Contract Documents are a single integrated document, and as such all Specification Sections apply. It is the responsibility of the Contractor and its subcontractors to review all sections and ensure a complete and coordinated project.

B. Related Specification Sections include, but are not limited to, the following:

1. Sections of the Specifications specifying equipment and/or systems producing electrical power.

2. Division 16 – Electrical

3. Division 17 – Instrumentation and Controls

1.04 STANDARDS AND CODES

ATS units and accessories, including installation of same, shall meet or exceed the applicable requirements of the following standards and codes (latest edition):

A. UL 1008 - Standard for Automatic Transfer Switches

B. NFPA 70 - National Electrical Code, including use in emergency and standby systems in accordance with Articles 517, 700, 701, and 702

C. NFPA 70E - Standard for Electrical Safety in the Workplace

D. NFPA 110 – Standard for Emergency and Standby Power Systems

E. ANSI/IEEE Standard 446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

F. NEMA ICS10 (formerly ICS2-447) - AC Automatic Transfer Switch Equipment
1.05 SUBMITTALS

A. Shop Drawings

Contractor shall prepare and submit complete and organized shop drawings and product data as specified herein and in accordance with the General Conditions, Section F - Labor and Construction. Shop drawings and product data shall include, but not be limited to, the following:

1. Manufacturer's product literature, specifications, performance capabilities, features and accessories, materials of construction, illustrations, and data in sufficient detail to demonstrate compliance with Specification requirements. Manufacturer’s literature and data shall be marked to clearly delineate all applicable information and crossing out all inapplicable information.

2. Plan, elevation, side, and front view arrangement drawings, including component identification, overall dimensions, weights, clearances, conduit entrance locations, and mounting or anchoring requirements.

3. Electrical wiring diagram showing ATS normal, emergency and load connections. Electrical wiring diagram showing all controller terminal block connections. In addition, provide a summary listing of all terminal block connections, including terminal block number, function, and a brief description of each connection.

4. Manufacturer's certificate of compliance or published data reflecting a UL 1008 listing for the ATS unit(s) to be supplied.

B. Operation and Maintenance Manual

Contractor shall submit a detailed Operation and Maintenance Manual for the equipment specified herein and incorporated into the Work. The Operation and Maintenance Manual shall be provided in accordance with the requirements of the District's General Conditions, and Section 01430.

Operation and maintenance manuals shall include, but not be limited to, the following:

1. Equipment Performance Data and Drawings

   a. Manufacturer's product literature, specifications, performance capabilities, features and accessories, materials of construction, and illustrations.
b. As-built general arrangement drawings.

c. As-built schematic diagrams and electrical wiring diagrams showing ATS normal, emergency and load connections, and controller input/output connections.

2. Equipment Installation Requirements

a. Complete, detailed installation instructions for all equipment and components.

3. Equipment Operation Data

a. Complete and detailed sequence of operation and operating instructions, including operator interface menus, programming, and setup parameters.

b. Printed list of all final setup parameters for each ATS unit, including factory settings and any field modifications to factory settings.

4. Equipment Service and Maintenance Data

a. Maintenance data shall include all information and instructions required by District's personnel to keep equipment properly cleaned and adjusted so that it functions correctly throughout its full design life.

b. Unloading, handling, and long term storage requirements.

c. Explanation with illustrations as necessary for each maintenance task.

d. Recommended schedule of maintenance tasks.

e. Troubleshooting instructions.

f. List of maintenance tools and equipment.

g. Recommended spare parts list.

h. Name, address and phone number of manufacturer and manufacturer's local service representative.

5. Manufacturer's Warranty
6. Provide a signed written certification report with the Final Operation and Maintenance Manuals, certifying that each ATS unit has been properly installed, calibrated and adjusted, and is suitable for satisfactory continuous operation under varying operating conditions, and meets all requirements specified in the Contract Documents.

1.06 QUALITY ASSURANCE

Each ATS unit shall be designed, fabricated, tested, furnished, and warrantied by a manufacturer that has been regularly engaged in the production of UL Standard 1008 listed ATSs for a minimum of 10 years, and the ATS unit to be supplied has been available on the open market for a minimum of 5 years. All ATS units shall be the product of the same manufacturer. ATS units shall be as manufactured by ASCO, Russelectric, Zenith, or equal.

The listing of specific manufacturers herein does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed herein are not relieved from meeting these specifications in their entirety; and, if necessary, they shall provide non-standard, custom equipment and/or products. Contractor shall be responsible for confirming that the proposed equipment and/or products will meet these specifications.

1.07 MANUFACTURER’S WARRANTY

Manufacturer shall guarantee all equipment against defects in material and workmanship for a period of two years from date of project acceptance. During the warranty period, manufacturer shall provide all labor and material required to repair or replace defective equipment at no cost to the District.

PART 2 – PRODUCTS

2.01 GENERAL

A. The ATS unit shall transfer load in delayed transition (break-before-make) mode. Transfer shall be accomplished with a user-defined interruption period in both directions, as specified herein. The load disconnect time delay shall be configured to be active for all transfers or to be bypassed in the event that the voltage of all three phases of the source the load is connected to drop below 70% of nominal.

B. Minimum ATS size (amperage rating) shall be as shown on the Drawings and as specified herein. The ATS unit shall be rated for continuous duty based on all load classes (inductive motors, resistive loads, electric discharge lamps, and tungsten lamps).
C. Each ATS unit shall be suitable for installation in an MCC section or in its own enclosure as shown on the Drawings and specified herein.

D. Unless specified otherwise, ATS units shall be 3-pole and suitable for application to 3-phase, 3-wire, 60 Hz, 480 V systems.

E. As a minimum, ATS units shall be 3-cycle rated in accordance with UL Standard 1008. Minimum UL 3-cycle close-on and withstand ratings at 480 VAC with any molded case circuit breaker (MCCB) matching the ATS size, specific coordinated MCCBs, or current limiting fuses shall be as follows:

<table>
<thead>
<tr>
<th>ATS Size (Amps)</th>
<th>Any MCCB</th>
<th>Specific Coordinated MCCB</th>
<th>Current Limiting Fuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 – 125</td>
<td>25,000 A</td>
<td>30,000 A</td>
<td>N/A</td>
</tr>
<tr>
<td>150 – 200</td>
<td>30,000 A</td>
<td>42,000 A</td>
<td>200,000 A</td>
</tr>
<tr>
<td>260 – 400</td>
<td>35,000 A</td>
<td>42,000 A</td>
<td>200,000 A</td>
</tr>
<tr>
<td>600</td>
<td>42,000 A</td>
<td>50,000 A</td>
<td>200,000 A</td>
</tr>
<tr>
<td>800 – 1200</td>
<td>50,000 A</td>
<td>65,000 A</td>
<td>200,000 A</td>
</tr>
<tr>
<td>1600 – 2000</td>
<td>85,000 A</td>
<td>85,000 A</td>
<td>200,000 A</td>
</tr>
<tr>
<td>2600 - 3000</td>
<td>100,000 A</td>
<td>100,000 A</td>
<td>200,000 A</td>
</tr>
</tbody>
</table>

2.02 CONSTRUCTION

A. The ATS unit shall be electrically operated and mechanically held. The electrical operators shall be dual-solenoid or dual-motor mechanisms, momentarily energized. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing.

B. The ATS unit contacts shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.

C. All main contacts shall be silver alloy composition designed to resist burning or pitting. Separate arcing contacts designed for rapid and reliable arc quenching and equipped with magnetic blowouts shall be provided.

D. Inspection of all contacts shall be possible from the front of the ATS without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit
the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

E. Designs utilizing components which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable. Insulated case and molded-case circuit breaker type switches are not acceptable.

F. Where specified for use on 3-phase, 4-wire systems, utilizing ground fault protection, a true 4-pole switch shall be provided with all 4-poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.

G. Power connection lugs shall be screw type or compression type, suitable for 75ºC (minimum) rated copper conductors. Where neutral conductors are to be solidly connected, a fully-rated neutral terminal plate or bar with AL-CU neutral lugs shall be provided.

H. Control components and wiring shall be front accessible without disassembly of operating linkages and with disconnection of power conductors. All control wiring shall be identified with tubular sleeve-type markers.

I. Each ATS unit shall be mounted and wired at the factory, including mounting and wiring of all door-mounted accessories.

2.03 CONTROLLER

A. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Controller components and wiring shall be front accessible.

B. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability and minimum maintenance.

C. A graphical LCD or VGA display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through a front accessible communications port. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.
D. Voltage sensing shall be true RMS type and shall be accurate to ±1% of nominal voltage. Frequency sensing shall be accurate to ±0.1Hz. Time delay settings shall be accurate to ±0.5% of the full scale value of the time delay.

E. As a minimum, the ATS unit including controller shall be capable of operating over a temperature range of 0 to 40°C.

F. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards.

G. Non-automatic (manual) operation of the ATS unit shall be selectable via the controller keypad, without requiring the use of an external manual operator or opening of the enclosure door.

H. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

1. IEC 60947-6-1 Multiple Function Equipment Transfer Switching Equipment, 61000-4 Testing and Measurement Techniques – Overview
   a. IEC 61000-4-2: Electrostatic Discharge Immunity Test (Level 4)
   b. IEC 61000-4-3: Radiated RF, Electromagnetic Field Immunity Test
   c. IEC 61000-4-4: Electrical Fast Transient/Burst Immunity Test
   d. IEC 61000-4-5: Surge Immunity Test
   e. IEC 61000-4-6: Conducted RF Immunity Test

2. EN55022 (CISPR11): Conducted and Radiated Emissions, Class B
2.04 OPERATION

A. Voltage and Frequency Sensing

1. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip settings capabilities (values shown as % of nominal unless otherwise specified).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Source</th>
<th>Dropout/Trip</th>
<th>Pickup/Reset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undervoltage</td>
<td>N &amp; E</td>
<td>70 to 98%</td>
<td>85 to 100%</td>
</tr>
<tr>
<td>Overvoltage</td>
<td>N &amp; E</td>
<td>102 to 115%</td>
<td>2% below trip</td>
</tr>
<tr>
<td>Underfrequency</td>
<td>N &amp; E</td>
<td>85 to 98%</td>
<td>90 to 100%</td>
</tr>
<tr>
<td>Overfrequency</td>
<td>N &amp; E</td>
<td>102 to 110%</td>
<td>2% below trip</td>
</tr>
</tbody>
</table>

2. Repetitive accuracy of all settings shall be within 1% at +25°C.

3. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

4. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage and frequency.

B. Time Delays

1. A time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, adjustable 0 to 6 seconds (minimum). It shall be possible to bypass the time delay from the controller user interface.

2. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes (minimum) for controlled timing of transfer of loads to emergency. It shall be possible to bypass the time delay from the controller user interface.

3. A time delay shall be provided on retransfer to normal, adjustable 0 to 240 minutes (minimum). Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.

4. The controller shall include a timer for the delayed transition transfer operation to control the transition time from neutral to the emergency source, adjustable 0 to 6 minutes (minimum).
5. The controller shall include a timer for the delayed transition transfer operation to control the transition time from neutral to the normal source, adjustable 0 to 6 minutes (minimum).

6. A cool down time delay shall be provided on shutdown of engine generator, adjustable 0 to 60 minutes (minimum).

7. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 6 minutes (minimum) time delay in any of the following modes:
   a. Prior to transfer only.
   b. Prior to and after transfer.
   c. Normal to emergency only.
   d. Emergency to normal only.
   e. Normal to emergency and emergency to normal.
   f. All transfer conditions or only when both sources are available.

8. All adjustable time delays shall be field adjustable without the use of special tools.

2.05 ADDITIONAL FEATURES

A. The user interface shall be provided with keys for the test/reset modes. The test mode shall simulate a normal source failure. The reset mode shall bypass the time delays on either transfer to emergency or retransfer to normal.

B. A set of contacts rated 5 A, 30 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
C. Auxiliary contacts, rated 10 A, 250 VAC, shall be provided consisting of:

1. One (1) normally closed dry contact, which shall open when the normal power source fails for "power failure" signal to RTU or controls as shown on the Drawings.

2. One (1) normally open dry contact, which shall close when the ATS is connected to the emergency source for "emergency power" signal to RTU or controls as shown on the Drawings.

D. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

E. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal (green) and emergency (red) source, as determined by the voltage sensing trip and reset settings for each source.

F. An engine generator exercising timer shall be provided to configure weekly and bi-weekly automatic testing of an engine generator set with or without load. It shall be capable of being configured to indicate a day of the week, and time weekly testing should occur.

G. The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Contractor shall install all equipment in accordance with the manufacturer’s written instructions, NEC standards, requirements and standards specified herein, and as shown on the Drawings.

B. Where an ATS unit is provided in an MCC or switchboard, Contractor shall anchor MCCs and switchboards in accordance with specified requirements for same. Where an ATS unit is provided in a separate free standing enclosure, Contractor shall anchor the enclosure to a reinforced concrete pad and floor slab in accordance with the calculations and details prepared by the manufacturer's engineer. Anchor bolt embedment depth shall be based on the thickness of the structure slab only, and shall
not include any portion of the raised concrete housekeeping pad beneath the equipment. Where an ATS unit is provided in a separate wall mounted enclosure, Contractor shall anchor the enclosure in accordance with the manufacturer's recommendations.

C. Verify the compatibility of conductor size, type, and stranding versus the power lugs furnished. Utilize correct lugs in all applications. Crimp compression lugs with manufacturer recommended tools.

D. Tighten all lugs, connectors, terminals, etc. in accordance with the equipment manufacturer's published torque tightening values for same.

E. Install arc flash hazard labels in accordance with NFPA 70E requirements.

F. Perform all pre-energizing checks as recommended by the manufacturer.

### 3.03 FIELD QUALITY CONTROL

A. Contractor shall provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this Section. The manufacturer's representative shall provide technical direction and assistance to the Contractor in equipment connections and adjustments, and testing of the assembly and components contained therein.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.

1. Perform insulation tests on each power phase (and neutral where provided) and verify low resistance ground connection on ground bus.

2. Connect all power wiring and control wiring and verify basic operation of external control and status signals.

3. Torque all bolted connections made in the field and verify all factory bolted connections.

4. Perform pre-startup of the ATS controller. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on record drawings.
3.04 FIELD ADJUSTMENTS AND TESTING

A. Follow the manufacturer's instructions and the Contract Documents concerning operating transfer times, voltage and frequency settings, time delay settings, and startup of components.

B. Follow the minimum requirements as stipulated in the NETA testing procedure for ATS assemblies.

C. Prepare a field report on tests performed, test values recorded, adjustments, etc., and provide same to District for review and approval.

3.05 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the generation of any reports.

B. Manufacturer's written certification shall be provided in accordance with Detailed Provision Section 16010.

3.06 CLEANUP

A. All parts of the electrical equipment and materials shall be left in a clean condition. Exposed parts shall be clean of dust, dirt, cement, plaster and other materials, and all oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and cleaned. Paint touch-up shall be applied to all scratches on panels and cabinets. Electrical cabinets or enclosures shall be free of spider webs.

B. Paint touch-up matching factory color and finish shall be applied to all scratches on panels and cabinets.

3.07 INSTRUCTION

After the equipment has been installed, tested, and adjusted, and placed in satisfactory operating condition, the equipment manufacturer shall provide classroom instruction to District's personnel in the use and maintenance of the equipment. Two (2) hours of instruction shall be provided, unless otherwise specified. Contractor shall give the District formal written notice of the proposed instruction period at least two weeks prior to commencement of the instruction period. Scheduled training shall be at a time acceptable to the District and the
manufacturer. During this instruction period, the manufacturer shall answer any questions from District personnel. The manufacturer’s obligation shall be considered ended when he and the District agree that no further instruction is needed.

END OF SECTION
SPECIFICATIONS - DETAILED PROVISIONS
Section 16480 - Motor Control Centers, Switchboards, and Panelboards

CONTENTS

PART 1 - GENERAL ............................................................................................................................. 1
  1.01 SCOPE ........................................................................................................................................ 1
  1.02 RELATED SECTIONS ................................................................................................................... 1
  1.03 REFERENCE STANDARDS, SPECIFICATIONS, AND CODES...................................................... 1
  1.04 SUBMITTALS .............................................................................................................................. 3
  1.05 DESIGN REQUIREMENTS ........................................................................................................... 6
  1.06 ARC-FLASH LIMIT ....................................................................................................................... 7
  1.07 COORDINATION ........................................................................................................................ 8
  1.08 QUALITY ASSURANCE ................................................................................................................ 8

PART 2 - MATERIALS ......................................................................................................................... 9
  2.01 MOTOR CONTROL CENTERS ..................................................................................................... 9
  2.02 SWITCHBOARDS ...................................................................................................................... 35
  2.03 LIGHTING PANELBOARDS AND TRANSFORMERS ................................................................. 43
  2.04 PROTECTIVE DEVICES .............................................................................................................. 49
  2.05 NAMEPLATES AND PLAQUES .................................................................................................. 55
  2.06 SPARE PARTS AND ACCESSORIES ............................................................................................ 56

PART 3 – EXECUTION....................................................................................................................... 58
  3.01 FACTORY TESTING ................................................................................................................... 58
  3.02 INSTALLATION ........................................................................................................................ 58
  3.03 FIELD QUALITY CONTROL ..................................................................................................... 59
  3.04 FIELD ADJUSTMENTS AND TESTING .................................................................................... 60
  3.05 MANUFACTURER’S CERTIFICATION ...................................................................................... 60
  3.06 CLEANUP .................................................................................................................................... 61
  3.07 INSTRUCTION ............................................................................................................................ 61
PART 1 - GENERAL

1.01 SCOPE

A. This section specifies the requirements for the design, fabrication, assembly, wiring, testing, delivery, and installation of low voltage (600 volt) motor control centers (MCCs), switchboards, and panelboards. Switchboards shall include utility service switchboards and distribution switchboards.

B. Contractor shall furnish and install MCCs, utility service switchboards, distribution switchboards, and panelboards as specified herein and indicated on the Drawings.

1.02 RELATED SECTIONS

A. The Contract Documents are a single integrated document, and as such all Specification Sections apply. It is the responsibility of the Contractor and its subcontractors to review all sections and ensure a complete and coordinated project.

B. Related Specification Sections include, but are not limited to, the following:

1. Sections of the Specifications specifying equipment and/or systems requiring electrical power and control.

2. Division 16 – Electrical

3. Division 17 – Instrumentation and Controls

1.03 REFERENCE STANDARDS, SPECIFICATIONS, AND CODES

A. Equipment and materials shall meet or exceed the applicable requirements of the following standards, specifications, and codes (latest edition):

Underwriters Laboratories (UL)

UL 44 Standard for Thermoset-Insulated Wires and Cables

UL 50 Standard for Enclosures for Electrical Equipment, Non-environmental Considerations
MCCs, Switchboards, and Panelboards
Section 16480 – 2

UL 50E Standard for Enclosures for Electrical Equipment, Environmental Considerations
UL 67 Standard for Panelboards
UL 98 Standard for Enclosed and Dead-Front Switches
UL 489 Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 508 Standard for Industrial Control Equipment
UL 845 Standard for Safety for Motor Control Centers
UL 891 Standard for Dead-Front Switchboards
UL 943 Standard for Ground-Fault Circuit Interrupters
UL 1063 Standard for Machine-Tool Wires and Cables
UL 1561 Standard for Dry Type General Purpose and Power Transformers

National Electrical Manufacturers Association (NEMA)
NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches
NEMA ICS 1 Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 V
NEMA ICS 2.3 Instructions for Handling, Operation and Maintenance of Motor Control Centers
NEMA ICS 4 Terminal Blocks
NEMA ICS 5 Industrial Control Systems, Control Circuit and Pilot Devices
NEMA ICS 6 Enclosures
NEMA ICS 18 Industrial Control and Systems: Motor Control Centers
B. Equipment shall bear the appropriate labels and markings in accordance with above standards, specifications and codes. Equipment shall be designed, manufactured, and tested in certified International Organization for Standardization (ISO) 9001 facilities.

1.04 SUBMITTALS

All submittals shall be in accordance with the General Conditions and requirements specified herein.

A. Shop Drawings

Contractor shall prepare and submit complete and organized information, drawings, and technical data for all equipment and components. All drawings shall be legible and reduced to a maximum size of 11” x 17” for inclusion within the submittal. Shop drawings shall include, but not be limited to, the following:
1. Manufacturer’s product literature and specifications for all major components including, but not limited to, the following: circuit breakers and fuse information (including time current characteristics), motor starters, overload relays, control power transformers, pilot devices, relays, timers, fans, heaters, thermostats. Product literature and specifications shall be marked to clearly identify all applicable information and crossing out all inapplicable information. Sufficient data and detail shall be provided to demonstrate compliance with these specifications.

2. Drawings showing structure elevation and plan views with dimensional information, including, but not limited to: structure height and depth, section widths, location of shipping splits, required bus splices, conduit stub up locations, and anchorage holes.

3. Single line diagrams and schematic wiring diagrams for each structure. Schematic wiring diagrams shall clearly identify internal and external devices, and all remote contacts and signals.

4. Structure descriptions with the following: bus ratings, enclosure ratings, short-circuit withstand rating, and other information to demonstrate compliance with Contract Document requirements.

5. Component schedule, including, but not limited to: circuit breakers, disconnect switches, motor circuit protectors, and motor starters.

6. Drawings showing proposed control unit layouts for each different unit configuration with the location of all control pilot devices clearly shown (control station plate or control unit door). Each pilot device shall be clearly labeled on the drawings.

7. Unit descriptions including information such as, starter sizes, circuit breaker frame sizes, circuit-breaker continuous amperage ratings and interrupting ratings, and all proposed options/accessories.

8. Terminal size ranges for all cable connections (line and load sides).

9. Nameplate schedule for all structures and sections.

10. Short-circuit and Protective Device Evaluation Study, Protective Device Coordination Study, and Arc-Flash Hazard Study per Section 16040.

11. Utility company’s written approval of electrical service equipment drawings.
12. Design calculations and details for equipment seismic design and restraint. Calculations and anchorage details shall be prepared and stamped by a Registered Professional Civil or Structural Engineer in the State of California. Equipment seismic design and restraint calculations shall be provided for all motor control centers and switchboards. Calculations shall include anchor bolt type, size, locations, and embedment depth. Anchor bolt embedment depth shall be based on the thickness of the structure floor slab only, and shall not include any portion of the raised concrete housekeeping pad beneath the equipment structures. Calculations shall be performed in accordance with the California Building Code (latest edition) for Occupancy Category IV, Essential Facilities.

13. Manufacturer’s installation instructions, including:

   a. Receiving, handling, and storage instructions.

   b. General information for nameplate data, serial numbers, UL markings, and short-circuit ratings.

   c. Installation procedures including seismic requirements, splicing procedures, and bus torque specifications.

   d. Conduit and cable installation.

   e. Grounding requirements.

   f. Installing and removing plug-in units.

   g. Arc-flash protection labeling.

   h. Operation of operator handles and unit interlocks.

   i. Checklists before energizing.

   j. Procedures for energizing equipment.

B. Operation and Maintenance Manuals

Contractor shall submit a detailed Operation and Maintenance Manual for the equipment specified herein and incorporated into the Work. The Operation and Maintenance Manual shall be provided in accordance with the requirements of the District's General Conditions, and Section 01430.
Operation and maintenance manuals shall include, but not be limited to, the following:

1. Installation instructions, as specified herein.
2. Safety precautions, including protective equipment and clothing.
3. Pre-energizing and energizing procedures for MCCs, switchboards, and panelboards.
4. Maintenance procedures, including: inspection and cleaning, servicing, disconnect switch and contact lubrication, and testing.
5. Maintenance procedures after a fault condition.
6. Troubleshooting procedures.
7. Technical data and illustrations.
8. Replacement parts list.
9. Manufacturer warranties.
10. Contact Information, including name, address, and telephone number of manufacturer and manufacturer’s local service representative.

1.05 DESIGN REQUIREMENTS

A. Provide equipment conforming to the requirements of NFPA 70, unless more stringent requirements are specified herein or indicated on the Drawings. NEMA rated and UL listed equipment is specified, and shall be provided when available. Equipment shall meet NEMA and UL construction and rating requirements as specified. No equivalent will be acceptable. Immediately notify the District of any requirements of the specifications or Contractor proposed materials or assemblies that do not comply with UL or NEMA. International Electrotechnical Commission (IEC) rated equipment will not be considered an acceptable alternative to specified NEMA ratings.

B. Equipment, conduit, and wiring sizes indicated on the Drawings, including motor sizes and associated electrical equipment ratings, are minimum requirements. Contractor shall verify all actual equipment and motor full-load and locked rotor current ratings. Contractor shall coordinate the actual current rating of equipment furnished with the size of the branch circuit conductors, motor controller, motor overload relay, and branch circuit overcurrent protection.
The branch circuit conductors shall have a carrying capacity of not less than 125% of the actual motor full-load current rating. The size of the branch circuit conductors shall be such that the voltage drop from the overcurrent protection devices up to the equipment shall not be greater than 2% when the equipment is running at full load and rated voltage. Conductor ampacities shall be derated in accordance with NEC, Table 310-16 for ambient temperatures of 114 to 122°F.

The motor running overcurrent protection devices shall be ambient temperature compensated for temperatures up to 50°C and be rated or selected to trip at no more than 125% of the motor full-load current rating for motors marked to have a temperature rise not over Class B above 50°C ambient or motors marked with a service factor not less than 1.15, and at no more than 115% for all other types of motors.

The motor branch circuit overcurrent protection device shall trip open in 10 seconds or less on locked-rotor current of the motor. This device shall also protect the motor branch circuit conductors and the motor controller against overcurrent due to short-circuits or grounds. The motor control circuits shall have overcurrent protection of the type indicated on the Drawings and specified herein.

Contractor shall make the necessary adjustments to wiring, conduit, motor controllers, disconnects, branch circuit protection, and other affected material or equipment to accommodate the motors actually furnished, all at no additional cost to the District.

C. Contractor shall verify that proposed equipment will fit into the available space for same. Prior to equipment fabrication, Contractor shall notify the District of any potential interferences or conflicts between the proposed equipment and corresponding installation locations, including associated conduit and conductors.

1.06 ARC-FLASH LIMIT

A. Contractor shall provide an Arc-Flash Hazard Study per Section 16040 to determine potential arc-flash incident energies, arc-flash boundaries, shock hazard boundaries; required personal protective equipment (PPE) for all energized electrical equipment; and arc-flash and shock hazard warning labels.

B. Unless specified otherwise, the study shall include all switchboard, emergency power transfer switch, MCC, and panelboard electrical circuits from the electric utility power source(s) and emergency power source(s) to and including all electrical equipment and panelboards rated 208 V and greater.
C. Wherever possible, the proposed electrical equipment, including MCCs, switchboards, and panelboards, shall be designed, manufactured, and supplied to limit the potential arc-flash incident energy to 8 cal/sq cm or less (PPE Category 2). The firm performing the studies shall coordinate with Contractor, the District, and the electrical equipment manufacturers to assist in achieving this requirement.

D. Arc-flash and shock hazard warning labels shall be provided for MCCs, switchboards, and panelboards per Section 16040. Where the main protective device is specified to be equipped with an arc-flash reduction maintenance system, all MCCs, switchboards, and panelboards shall be provided with two (2) sets of labels. One (1) set shall be provided for the normal operating mode and one (1) set shall be provided for the arc-flash reduction maintenance system operating mode.

1.07 COORDINATION

A. The general arrangement of the MCCs, switchboards, and panelboards is shown on the Contract Drawings. Any modifications of the equipment arrangement or device requirements as indicated on the Drawings shall be subject to District approval. If any conflicts occur necessitating a departure from the Drawings, a written explanation and details for said departure shall be submitted and approved by the District prior to implementing any change. All equipment shall be completely factory assembled. The MCCs and switchboards may be disassembled into sections, if necessary, for convenience of handling, shipping, and installation.

B. Where project requirements include construction of a new electrical service or upgrading an existing electrical service, Contractor shall coordinate all required work with Southern California Edison (SCE) and the District. All electrical service equipment and material shall be in strict accordance with SCE requirements. Prior to commencing construction of electrical service facilities, Contractor shall submit shop drawings of proposed electrical service equipment and material to SCE and District for review and approval.

1.08 QUALITY ASSURANCE

A. The District believes that the manufacturers listed herein are capable of producing equipment and/or products that will satisfy the requirements of these specifications. The listing of specific manufacturers herein does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed herein are not relieved from meeting these specifications in their entirety; and, if necessary, they shall provide non-standard, custom equipment and/or products. Contractor shall be responsible for confirming that the proposed equipment and/or products will meet these specifications.
B. Model numbers supplied herein are provided for information purposes only, to assist Contractor in selecting equipment that conforms to the Specification and Drawing requirements. In case of any conflict between model numbers provided and the descriptive requirements specified herein, the descriptive requirements shall govern.

PART 2 - MATERIALS

2.01 MOTOR CONTROL CENTERS

A. General

MCCs shall be 600 V class suitable for operation on a three-phase, 480 V, 60 Hz system. MCCs shall be configured for 3-wire or 4-wire systems, as indicated on the Drawings. MCCs shall be manufactured by Eaton/Cutler-Hammer, Schneider Electric/Square D, Allen Bradley, or General Electric (no substitutes).

B. Structures

1. Structures shall be totally enclosed, dead-front, free-standing assemblies. Structures shall be capable of being bolted together to form a single assembly.

2. The overall height of MCCs shall be 90 inches (nominal), not including base channels, lifting angles, baffles, or plenums. Structures shall contain horizontal wireways at the top and bottom of each section. A minimum of 72 inches of vertical compartments shall be available for mounting of control units, protective devices, transformers, lighting panelboards, etc.

3. For shipment and installation, each MCC shall be provided with rigid removable or non-removable base channels enclosing all four-sides of the equipment, and removable lifting angles. Non-removable base channels shall be provided with welded closing plates at the open ends the channels.

4. The total width of one section shall be 20 inches; widths of 25 inches, 30 inches, or 35 inches shall be provided where required for larger devices or where indicated on the Drawings.

5. The minimum depth of the MCC shall be 20 inches.

6. Each 20 inch wide standard section shall be provided with all the necessary hardware and bussing for modular plug-on units to be installed. All unused space shall be covered by hinged blank doors and equipped to accept future units. Vertical bus openings shall be covered by manual bus shutters.
7. Each section shall include a top plate (single piece or two-piece). Top plates shall be removable for ease in cutting conduit entry openings.

8. MCC Structures Located Indoors

Unless indicated otherwise on the Drawings, MCC structures located indoors shall be provided with NEMA Type 1A (gasketed general purpose) enclosures.

9. MCC Structures Located Outdoors

Unless indicated otherwise on the Drawings, MCC structures located outdoors shall be provided with NEMA Type 3R, non-walk-in (rainproof) enclosures. MCC NEMA Type 3R, non-walk-in enclosures shall be based on NEMA Type 1A enclosures with a NEMA 3R wrapper. The additional housing and gasketing supplied by the NEMA 3R wrapper shall provide protection from rain, sleet, and ice. As a minimum, MCC NEMA Type 3R, non-walk-in enclosures shall comply with the following requirements:

   a. The enclosing NEMA 3R wrapper shall be constructed of 12 gauge galvanneal steel with a flat or sloped roof line. Sloped roof lines shall be sloped from front to rear at a minimum of 1/2 inch per foot. Doors constructed of 14 gauge steel are acceptable if the doors are provided with suitable welded-in stiffening pans to prevent deflection. Doors constructed of 14 gauge steel without stiffening pans are not acceptable. Gasketing shall be provided all around door closing flanges (four sides).

   b. Each NEMA 3R wrapper split or section shall have a minimum of 29 inches working clearance from hinge flange to door closure flange or hinge to hinge with double doors. The width of open unobstructed area when door(s) are open shall be 29 inches minimum.

   c. NEMA 3R wrapper splits shall be coordinated with the MCC section splits. Cabinet spacers shall be provided at MCC section splits to permit full opening (90 degrees, minimum) of all MCC doors without interfering with the NEMA 3R wrapper doors. MCC shall be provided with all cabinet spacers, wireway extensions, horizontal bus splice kits, and ground bus splice kits required to interconnect MCC sections and provide the necessary separation for MCC doors to fully open. All MCC cabinet connections shall be provided with gaskets to maintain the specified NEMA 1 gasketed rating.

   d. The rear access covers shall be flanged on four sides, and gasketed. One piece flat or multi-piece flat lipped covers are not acceptable.
e. The distance in front of a NEMA 1A MCC section to the inside of the outer
NEMA 3R wrapper door(s) shall be 11 inches, minimum.

f. Lighting shall be provided using LED lighting fixtures, single-tube, with
length as necessary for width of NEMA 3R wrapper split. A light switch
shall be provided on side extension for each MCC shipping split, and shall
be furnished with a stainless steel cover plate.

g. Convenience receptacles shall be provided for each MCC shipping split.
Receptacles shall be duplex GFCI type, with stainless steel cover.

h. Control power transformers with primary and secondary fuse protection
shall be provided to supply power to the NEMA 3R wrapper interior
lighting and convenience receptacles, unless indicated otherwise on the
Drawings. Supply voltage shall be 120 volts, 60 Hz. The control power
transformers shall be prewired at the factory to all lights and receptacles.

i. Where required for MCC ventilation, NEMA 3R wrapper doors shall be
provided with louvered or hooded ventilation openings at the top and
bottom. Louvered openings shall be integrally molded into the doors and
covered by interior mounted air filters. Hooded openings shall be clear
door openings covered by exterior weatherproof hoods and interior
mounted air filters. Each weatherproof hood shall be provided with a
removable insect screen at the bottom. Air filters shall be washable
aluminum mesh type, gasketed on all sides, and removable (without the
use of tools) for cleaning.

j. NEMA 3R wrapper front door handles shall have provisions for padlocking
and shall be equipped with wind stops.

k. Both MCCs and Switchboards (if applicable) shall have the same NEMA 3R
wrapper design and appearance, and shall be UL approved.

C. Materials

1. Steel material shall comply with UL 845 requirements.

2. Each MCC shall consist of one or more vertical sections of heavy gauge steel
bolted together to form a rigid, free-standing assembly. Vertical sections shall
be made of welded side-frame assemblies formed from a minimum of 12 gauge
steel. Internal reinforcement structural parts shall be of 12 and 14 gauge steel to
provide a strong, rigid assembly. The entire assembly shall be constructed and
packaged to withstand normal stresses included in transit and during installation.
D. MCC Finish

1. All steel parts shall be provided with UL listed acrylic/alkyd baked enamel paint finish or TGIC Powder Coat, except plated parts used for ground connections. All painted parts shall undergo a multi-stage treatment process, followed by the finishing paint coat.

2. Pre-treatment shall include:
   a. Hot alkaline cleaner to remove grease and oil.
   b. Iron phosphate treatment to improve adhesion and corrosion resistance.

3. The paint shall be applied using an electro-deposition process to ensure a uniform paint coat with high adhesion.

4. The standard paint finish shall be tested to UL 50 per ASTM B117 (5% ASTM Salt Spray) with no greater than 0.125 inch loss of paint from a scribed line.

5. Paint color for MCC NEMA 1 enclosures shall be #49 medium light gray per ANSI Standard Z55.1 (60-70 gloss) on all exterior surfaces, unless specified otherwise. Control station plates and escutcheon plates shall be painted a contrasting gray. All unit interior surfaces shall be painted white for better visibility inside the unit, except for unit handle mechanism side plates.

6. Paint color for MCC NEMA 3R enclosures (NEMA 3R wrappers) shall be white (60-70 gloss) on all surfaces unless specified otherwise.

E. Wireways

1. Horizontal Wireways
   a. Wireways shall be located at the top and bottom of the MCC.
   b. Wireways shall be a minimum of 6 inches in height and shall extend the full depth of the vertical sections to allow maximum flexibility in locating conduit and routing field wiring for the MCC. Where indicated on the Drawings, pull boxes shall be provided to extend the height of the top horizontal wireway by 12 inches.
   c. Wireways shall be continuous across the length of the MCC, except where access needs to be restricted for horizontal isolation requirements.
d. Wireways shall be isolated from the power buses.

e. Wireways shall have removable covers held in place by captive screws.

2. Vertical Wireways

a. A full height vertical wireway, independent of the plug-in units, shall be provided in each standard vertical section.

b. Wireways shall be isolated from the vertical and horizontal buses.

c. Isolation shall be provided between the wireway and unit compartments.

d. Wireway tie bars shall be provided in each section.

e. Wireways shall be covered with hinged and secured access doors. Access to the wireways shall not require opening control unit doors.

F. Barriers

1. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass filled polyester support assembly that braces the bus against the forces generated during a short-circuit. The horizontal bus shall be isolated from the top horizontal wireway by a rigid non-conductive barrier.

2. Isolation of the vertical bus compartment from the unit compartment shall be by means of a full height insulating barrier. Vertical busing shall be provided with a glass-filled polyester barrier that provides bus insulation and braces the bus against the forces generated during a short-circuit. These barriers shall have openings at a maximum spacing of 6 inches for unit stab-on connections. Openings shall be provided with manual or automatic shutters to close-off the stab openings when plug-in units are removed. Manual covers shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.
G. **Busing**

1. The main horizontal busing shall be tin-plated copper and shall be rated at the amperage indicated on the Drawings; however, the bus shall have a minimum ampere rating of 600 A. The vertical bus connecting an incoming power feeder cable to the horizontal bus shall have the same ampere rating as the main horizontal bus. Unless specified otherwise, horizontal bus bars shall extend the length of the MCC. Bus ratings shall be continuous and shall be based on a 65°C maximum temperature rise over a 40°C ambient temperature in compliance with UL standards. The main bus shall be isolated from the horizontal wireways, and all bus connections shall be front-accessible for ease of maintenance. Provisions shall be provided for splicing additional sections onto either end of the MCC.

2. Vertical busing feeding unit compartments shall be tin-plated copper and shall be securely bolted to the horizontal main busing. The vertical busing shall be rated at the amperage indicated on the Drawings; however, the busing shall have a minimum effective ampere rating of 600 A. If center horizontal bus construction is utilized, then the rating shall be 300 A above and below the horizontal bus for an effective rating of 600 A. If a top or bottom mounted horizontal bus is utilized, the full vertical bus shall be rated for 600 A. The vertical buses shall be continuously braced by a high strength, non-conductive, non-tracking, glass-filled polyester material and isolated from the unit compartments by a non-conductive, polycarbonate molded cover. The vertical power bus shall be isolated from the horizontal power bus, except where necessary to connect the vertical bus to the horizontal bus.

3. Unit power stabs for engaging the power bus shall be tin-plated copper and shall be provided with stainless back-up springs to provide and maintain a high pressure connection to the vertical busing. Power cable terminations at the plug-in stabs shall be maintenance-free compression type connections.

4. A tin-plated copper ground bus shall be provided that runs the entire length of the MCC. The ground bus shall be a minimum of 0.25 inch x 2.0 inch and be rated for 600 A (minimum). A mechanical lug shall be provided at each end of the MCC for connecting #1/0 AWG to 250 kcmil external ground cables. The ground bus shall be provided with a minimum of six (6) 3/8 inch diameter holes for each vertical section to accept Contractor-supplied ground lugs for any loads requiring a ground conductor.

5. Each vertical section shall be provided with a copper vertical ground bus that is solidly connected to the horizontal ground bus. This vertical ground bus shall be installed so that the plug-in units engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected upon removal of the plug-in unit.
6. The horizontal and vertical busing shall be mounted on supports constructed of materials having high dielectric strength, high impact strength, and low moisture absorbency.

7. The system shall be rated for an available short-circuit capacity of not less than 65,000 RMS amperes in accordance with NEMA standards. If the results of the Contractor’s Electrical Short-circuit and Protective Device Evaluation and Coordination Study, as accepted by the District, indicate that a higher short-circuit duty rating of the MCC is required, Contractor shall furnish the MCC with that higher rating.

H. Disconnects

1. Main Lug Compartment (if indicated on the Drawings)
   a. If no overcurrent protection is indicated on the Drawings for incoming power, MCC shall be provided with a main incoming-line lug compartment.
   b. Lug connections shall be located at the back of the enclosure to reduce the potential hazard of contacting the lugs when opening the compartment door.
   c. Lugs shall accommodate the incoming power conductors as indicated on the Drawings. Lugs shall be provided by the MCC manufacturer.

2. Main Circuit Breaker Disconnect (if indicated on the Drawings)
   a. Lugs to accommodate the incoming power conductors as indicated on the Drawings shall be provided by the MCC manufacturer.
   b. Circuit breaker frame and trip rating shall be as indicated on the Drawings.
   c. The interrupting capacity rating shall meet or exceed the main bus rating of the MCC.
   d. The main circuit breaker shall be a molded case circuit breaker with solid-state trip unit or insulated case power circuit breaker per Part 2.04 herein.
   e. Provide a removable protective barrier to reduce the possibility of contact with the line terminals.
MCCs, Switchboards, and Panelboards
Section 16480 – 16

f. Where specified on the Drawings, provide one normally open and one normally closed circuit breaker auxiliary contact that follows the position of the circuit breaker main contacts for indication of ‘On’ or ‘Off/Tripped’.

3. Feeder Disconnects and Transformer Disconnects

a. The disconnecting means for feeders and transformers shall be molded case circuit breakers per Part 2.04 herein.

b. The interrupting capacity rating shall meet or exceed the main bus rating of the MCC.

c. Circuit breaker frame and trip rating shall be as indicated on the Drawings.

4. Motor Starter Disconnects

a. Combination Full-Voltage Starters:

i. The disconnecting means for combination full-voltage starters (across-the-line starters) shall be motor circuit protectors. Motor circuit protectors shall be provided per Part 2.01K herein.

ii. The short-circuit rating of the motor circuit protector shall be greater than or equal to the MCC main bus rating.

b. Solid-State Controllers (Solid-State Reduced Voltage Motor Controllers) and Variable Frequency Drives

i. The disconnecting means for a solid-state controller or a variable frequency drive shall be a molded case circuit breaker.

ii. The short-circuit rating of the circuit breaker shall be greater than or equal to the MCC main bus rating.

I. Typical Motor Control Unit Construction

1. Units with circuit breaker disconnects through 400 A frame, and fusible switch disconnects through 400 A, shall connect to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

2. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to prevent accidental contact with those parts.
3. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All plug-in units shall use a twin-handle camming lever located at the top of the bucket to rack in and out the plug-in unit. The cam lever shall work in conjunction with the hanger brackets to ensure positive stab alignment.

4. A lever handle operator must be provided on each disconnect. With the unit stabs engaged onto the vertical bus and the unit door closed, the handle mechanism shall allow complete "On/Off" control of the unit. All circuit breaker operators shall include a separate "Tripped" position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door. Clear indication of disconnect status shall be provided by the following operator handle positions:

   a. Handle "On" position shall be up or to the left and within 45 degrees of being parallel to the face of the equipment.

   b. Handle "Off" position shall be down or to the right and within 45 degrees of being parallel to the face of the equipment.

   c. The minimum separation between the "On" and "Off" positions shall be 90 degrees.

   d. On circuit breaker disconnects, the handle "Tripped" position shall be perpendicular to the face of the equipment +/- 30 degrees. Minimum separation between "On" and "Tripped" shall be 30 degrees. Minimum separation between "Tripped" and "Off" shall be 45 degrees.

5. A mechanical interlock shall prevent an operator from opening the unit door when the disconnect is in the "On" position. Another mechanical interlock shall prevent an operator from placing the disconnect in the "On" position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.

6. A non-defeatable interlock shall be provided to prevent installing or removing a plug-in unit unless the disconnect is in the "Off" position.

7. The plug-in unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.

8. Provisions shall be provided for locking all disconnects in the "Off" position with up to three padlocks.
9. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.

10. Unit interior surfaces (back, sides and bottom plates) shall be painted white, except for handle mechanism side plates.

J. Wiring and Terminations

1. Wherever possible, copper compression type lugs shall be provided for all line and load terminations, and shall be suitable for copper cable rated for 75°C of the size as indicated on the Drawings.

2. Copper compression type lugs shall be provided for all grounding conductor terminations to the ground bus.

3. Unless indicated otherwise on the Drawings, MCC wiring shall be NEMA Class II, Type B, with wiring schematics showing field devices and connections.

4. Where fine stranded conductors, Class C and higher (such as DLO cable) are utilized for internal wiring, all terminations in mechanical lugs shall be provided with copper flex-cable compression adapters to properly confine the fine strands and prevent overheating of the connection and wire pullout from lugs. The flex-cable compression adapters shall fit mechanical set-screw mechanical lug type connectors and shall be sized for the full current carrying capacity of the cable. The adapters shall be provided a flared barrel-opening to allow easy cable insertion. The adapter shall be constructed of wrought copper with pin of Class B stranded copper conductor, rated for 600V and 105°C cable, and shall be UL listed. Pin length shall be sufficient to allow full engagement into the mechanical lug. Flex-cable copper compression adapters shall be Shoo-pin PT-FX Series, as manufactured by Greaves Corporation, or equal.

5. Control Wiring Terminal Blocks

a. All starter units shall be provided with unit control terminal blocks (Type B wiring).

b. Terminal blocks shall be the pull-apart type with a minimum rating of 250 VAC and 10 A. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.
c. When Type C wiring is specified, all starter units shall be provided with unit control terminal blocks as described for Type B wiring along with power terminal blocks for NEMA size 1-3 units. An additional set of terminal blocks shall be provided in a terminal compartment located in each section. These terminal blocks shall be pre-wired to the unit terminals so that all field control connections can be made at the terminal compartments.

6. All internal wires shall be labeled at each termination. Terminals shall also be identified with labels showing the terminal block and terminal numbers.

7. Control wires connected to door mounted components shall be tied and bundled in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall allow the door to swing full open without undue stress or abrasion. Bundles shall be held on each side of hinge by mechanical fastening devices.

8. Terminals on door mounted components shall be provided with finger-safe protective barriers; or alternatively, a single clear plastic protective barrier shall be provided covering all terminals.

K. Combination Full-Voltage Motor Controllers (Across-the-Line Starters)

1. Combination motor controllers shall be full-voltage non-reversing, unless otherwise specified herein or on the Drawings. Combination full-voltage motor controllers shall utilize motor circuit protectors and magnetic motor starters. Each combination unit shall have a short-circuit rating greater than or equal to the MCC main bus rating. The motor circuit protector shall provide adjustable magnetic protection, and shall be adjustable to 1700% of motor nameplate full load current in compliance with NEC requirements. All motor circuit protector combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the motor circuit protector. Motor circuit protectors shall be Eaton Type HMCP, or equal.

2. Where specified on the Drawings, motor circuit protectors shall be provided with auxiliary contacts (one normally open and one normally closed) that follow the position of the motor circuit protector main contacts for indication of "On" or "Off/Tripped".
3. Magnetic motor starters shall be NEMA ICS 2, alternating current Class A magnetic controllers for induction motors rated in horsepower. Magnetic motor starters shall be equipped with totally enclosed, double-break silver alloy contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring. Starter wiring shall be straight-through with all terminals clearly marked. Each starter shall be provided with necessary number of normally open and/or normally closed auxiliary contacts to perform all functions shown on the control ladder diagrams in the Drawings.

4. Starter coils shall be of molded construction and permanently marked with voltage, frequency and manufacturer part number. Unless specified otherwise, starter coil voltage shall be 120 VAC.

5. Starters shall be provided with bimetallic-type overload relays or solid-state overload relays for motor protection. Overload relays for motor protection shall be as indicated on the Drawings and as specified herein. Unless specified otherwise, bimetallic-type overload relays shall be provided on starters for motors of less than 5 HP, and solid-state overload relays shall be provided on starters for motors of 5 HP and greater. For each combination motor controller, Contractor shall verify motor rating and coordinate starter and overload relay size with the horsepower and starting characteristics of the actual motor furnished.

6. Bi-metallic overload relays shall be ambient compensated with interchangeable heaters, calibrated for 1.0 and 1.15 service factor motors. Electrically isolated normally open and normally closed contacts shall be provided on the relay. The relay shall be capable of accepting additional auxiliary contacts. Visual trip indication shall be standard. A test trip feature shall be provided for ease of troubleshooting and shall be conveniently operable without removing components or the motor starter. The overload shall be capable of 20% (minimum) adjustability (plus or minus) and single-phase sensitivity. The overload relay shall be provided with an isolated alarm contact, and manual reset.

7. Solid-state overload relays shall be integral with the motor starter, and shall be listed under UL Standard 508. Solid-state overload relays separate from the motor starter are not acceptable. As a minimum, solid-state overload relays shall have the following features and capabilities:

   a. Self-powered.

   b. Class 10, 20, or 30 selectable tripping characteristics.
c. Manual or automatic reset. Automatic reset shall be provided if indicated on the Drawings. Reset shall be electronic 120 VAC.

d. Selectable "On/Off" phase loss protection. The relay shall trip in 10 seconds or less under phase loss condition.

e. Selectable "On/Off" phase imbalance protection. The relay shall trip in 10 seconds or less under phase imbalance condition.

f. Visible trip indication.

g. One normally open and one normally closed isolated auxiliary contact and capable of accepting additional auxiliary contacts.

h. Test button that operates the normally closed contact.

i. Test trip function that trips both the normally and normally closed contacts.

j. A current adjustment range of 3:1, or greater.

k. Embedded, selectable "On/Off" ground fault protection shall be an available option, and shall be provided where indicated on the Drawings. Relay shall trip when ground fault is detected at 50% of full load ampere setting.

l. An LED that provides self-diagnostic information.

m. An LED that aids in commissioning by indicating running current is too high compared to the FLA dial.

Solid-state overload relays shall be Eaton Type C440, or equal.

L. Solid-State Reduced Voltage Motor Controllers (Soft Starters)

1. The solid-state reduced voltage motor controller unit shall be a combination disconnect/soft starter, MCC-style unit. A molded case circuit breaker shall be provided for NEC required branch circuit protection. The branch circuit protection shall have an external operator. Wiring between the soft starter and the disconnect shall not be disturbed when removing or installing the soft starter controller unit from the MCC. Units shall be of modular construction so that units of the same size can be interchanged without modifications to the MCC structure.
2. All conducting parts on the line side of the unit disconnect shall be isolated to prevent accidental contact with those parts.

3. Soft starter units rated for standard duty (up to 156 A, FLA for 125 HP motor per NEC) shall be plug-in units which connect to the MCC vertical bus through a spring-reinforced stab-on connector. Units rated higher than 156 A shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

4. The soft starter disconnect shall be a molded case circuit breaker per Part 2.04 herein.

5. For each soft starter unit, Contractor shall verify motor rating and coordinate soft starter and disconnect size with the horsepower and starting characteristics of the actual motor furnished.

6. All plug-in soft starter units shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors engage/release.

7. All soft starter units shall be provided with unit control terminal blocks for use in terminating field wiring. Terminal blocks shall be pull-apart type, 250 V, and rated for 10 A. All current-carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. The terminals used for field connections shall be accessible so they can be wired without removing the unit or any of its components.

8. The enclosure shall include a door-mounted digital keypad for adjusting the soft starter parameters and viewing the motor, soft starter, and fault status without opening the enclosure door.

9. Each soft starter shall include a shorting contactor which closes after full voltage has been applied to the motor by the soft starter to reduce the current carrying duty on the SCRs. The shorting contactor shall be rated to carry the motor full load current during steady state operation.

10. Electrical Ratings

   a. The soft starter unit shall be designed to operate from an input voltage between -10% and +10% of nominal voltage rating.

   b. The soft starter unit shall operate from an input voltage frequency range of +/-5%.
c. The soft starter unit shall be capable of supplying 350% of rated full load current for 20 seconds at the maximum ambient temperature.

d. All soft starter unit power and control devices shall be rated for: severe duty capable of 3 evenly spaced starts per hour at 350% of full rated current for 24 seconds per start without tripping.

e. The soft starter unit shall be provided with silicon-controlled rectifiers (SCRs) having a minimum peak inverse voltage (PIV) rating of 1800 VAC. Lower rated SCRs with protection by metal oxide varistors (MOVs) are not acceptable.

11. Protection

a. A microprocessor-based thermal protection system shall be included that continuously calculates the temperature rise of the motor and soft starter and provides:

   i. A motor overload fault that shall stop the motor if the windings have exceeded 125% of their rated temperature rise.

   ii. An electronic circuit with a time-constant adjustable to the motor's thermal cooling time-constant that ensures memorization of the thermal state even if power is removed from the soft starter.

b. The soft starter shall provide line and motor phase loss, phase reversal, underload, stall, and jam protection.

c. The soft starter integral protective features shall be active even when the shorting contactor is used to bypass the SCRs during steady state operation.

d. All units and options shall be constructed with protection provisions to pass UL 845 short-circuit testing criteria at a minimum of 100,000 A short-circuit current.

e. Diagnostic faults and soft starter status shall be displayed on the door-mounted keypad after a fault condition.

f. The motor shall be automatically protected from solid state component failure by one of the following means:

   i. Shunt trip coil to trip the disconnect in the event of a soft starter fault condition, including a shorted SCR.
ii. Isolation contactor that opens when the motor is stopped or when the controller detects a fault condition including a shorted SCR.

12. Adjustments and Configurations

a. All programming/configuration devices, display units, and field control wiring terminals shall be accessible on the front of the soft starter control module. All control circuit boards and electrical power devices shall be isolated to prevent exposure and accidental contact during routine adjustments.

b. Digital indication shall provide, as a minimum, the following conditions:

i. Soft starter status—ready, starting/stopping, run.

ii. Motor status—current, torque, thermal state, power factor, operating time, power in kW.

iii. Fault status—motor thermal overload, soft starter thermal fault, loss of line or motor phase, line frequency fault, low line voltage fault, locked rotor fault, motor underload, maximum start time exceeded, external fault, line phase reversal fault, and motor overcurrent fault.

c. As a minimum, a digital keypad shall be used to configure the following operating parameters:

i. Motor full load amps, adjustable from 40 to 100% of the soft starter’s rating.

ii. Current limitation on starting, adjustable from 200 to 700% of the motor current rating, not to exceed 350% of the soft start rating.

iii. Voltage ramp, adjustable from 1 to 60 seconds.

iv. Initial voltage, adjustable from 10 to 50% of nominal motor torque.

v. Maximum start time, adjustable from 1 to 250 seconds.

vi. Voltage boost duration, adjustable from 0.1 to 1 second.

vii. Selection of freewheel or soft stop.

viii. Linear (torque-controlled) deceleration ramp time, adjustable from 1 to 60 seconds.

ix. Selection of Class 10, 20, or 30 motor thermal overload protection.
d. As a minimum, a digital keypad shall be used to configure the following controller parameters:

i. Assignment of soft starter inputs and outputs.
ii. Activation of phase reversal protection.
iii. Reset of motor thermal state.
iv. Return to factory parameter settings.
v. Activation of self-test mode.
vi. Indication of elapsed time in hours of starting, running and stopping.

e. As a minimum, output relays shall provide the following status indications:

i. One normally open SPST for indication of trip.
ii. One normally open SPST for indication that soft starter is running.

f. As a minimum, additional inputs and outputs shall be available to provide the following status indications:

i. Two assignable control inputs for the following functions: external fault input, disable serial link control, second set of operating and controller parameters, or general fault reset.

g. Relay and I/O functions listed above shall be isolated with respect to common.

h. Serial communication shall be provided with a communications card capable of ModBus RTU or ModBus TCP.

13. Control Options

a. The soft starter's control circuit shall be fed from a fused line supply and shall be completely independent of the power circuit and separate from relay control logic.

b. The peripheral soft starter control circuitry shall be operated from a control power transformer included within the enclosure.

c. Operator devices shall be door-mounted. Unless indicated otherwise on the Drawings, the following operator devices shall be provided:

i. Green "Start" and red "Stop" pushbuttons.
ii. Three position "H-O-A" switch which provides for manual "Hand" start or remote "Auto" start from input relay contacts.

iii. Green "Run" pilot light illuminated whenever the soft starter run output is activated and no fault condition is present.

iv. White "Off" pilot light illuminated whenever the soft starter is supplied with control power and no run command is present.

14. Full-Voltage Bypass Starter

a. Where indicated on the Drawings, the soft starter unit shall include full-voltage starting capability to start and control the motor instead of the reduced voltage soft start method of starting the motor.

b. The full-voltage bypass starter shall include a magnetic motor starter as specified herein, and shall be capable of carrying the motor inrush and motor full load current.

c. A door-mounted "Normal/Bypass" selector switch shall be provided to enable the user to manually select the motor starting method. "Normal" mode shall provide reduced voltage starting using the soft starter. In "Bypass" mode, the soft starter shall be left inactive and the motor shall be started using the full-voltage (across-the-line) starter.

d. To protect the motor in "Bypass" mode, the magnetic motor starter shall be equipped with a bi-metallic or solid-state overload relay, independent of the soft starter.

e. The bypass starter components shall be fully integrated inside the soft starter control unit and shall be factory tested by the MCC manufacturer.

M. Control Devices and Miscellaneous Components

1. Control Transformers

Except as otherwise indicated on the Drawings, each motor control unit shall be provided with a control transformer. Control transformers shall comply with the following requirements:

a. Each control transformer shall be rated 480/120 V, single phase, 2 wire, 60 Hz, and shall conform to the applicable requirements of NEMA ST 1. The transformer shall have adequate volt-ampere capacity for the motor starter coil and all connected control function loads indicated, plus an additional 10 percent capacity. Transformer capacity shall be increased as required for any additional non-control function loads, such as
condensation heaters and ventilation fans. The transformer shall have a minimum rating of 150 VA.

b. Each control transformer shall be feed from the load side of the motor controller disconnect. Control transformers shall be provided with two primary fuses rated to interrupt 100,000 A at 600 V. One transformer secondary lead shall be provided with a time-delay, slow-blow fuse rated to interrupt 10,000 A at 250 V, and the other secondary lead shall be grounded. All fuses shall be provided with blown fuse indicators.

Where Drawings indicate control circuit power is provided from a source other than a unit transformer (e.g. a lighting panel circuit breaker) and an interlock is required with the motor controller disconnect, the disconnect shall be equipped with a normally open contact to isolate the externally powered control circuit from the source when the controller disconnect is open.

2. Control Relays

Control relays shall be general purpose, electrically operated, magnetically held, plug-in blade or pin style with DIN rail mountable socket and LED indicator. Control relays shall be UL listed with 10 A rated contacts (thermal continuous current at 120 VAC), and shall be provided with 120 VAC coils, unless specified otherwise. Number of poles and pole arrangement shall be as indicated on the Drawings and as specified herein. Control relays shall be as manufactured by Allen-Bradley, IDEC, OMRON, Potter-Brumfield, or equal.

3. Time Delay Relays

Time delay relays shall be general purpose, multi-range, multi-function, plug-in blade or pin style with DIN rail mountable socket and LED indicators (timing and timed out). Time delay relays shall be provided with multiple programmable timing ranges (0.5 sec to 24 hours, minimum) and multiple operating modes. As a minimum, relay operating modes shall include: on-delay, off-delay, repeat cycle off start, repeat cycle on start, and signal on/off delay. Time delay relays shall be UL listed with 5 A rated contacts (thermal continuous current at 120 VAC) non-inductive load, and shall be provided with 120 VAC coils, unless specified otherwise. Number of poles, pole arrangement, and maximum timing adjustment shall be as indicated on the Drawings and as specified herein. Time delay relays shall be as manufactured by Allen-Bradley, IDEC, OMRON, Potter-Brumfield, or equal.
4. Elapsed Time Meters

Elapsed time meters shall be electromechanical, NEMA Type 4X rated, with rectangular or round case suitable for flush panel mounting. Each meter shall have 6-digit (minimum) registers with counter numbers at least 3 mm high, and shall be non-resetable. White counter numbers on black backgrounds shall provide hour indication with the last digit in contrasting colors to indicate tenths of an hour. Each meter shall operate on 120 VAC input power. Elapsed time meters shall be as manufactured by Eaton, Honeywell/Hobbs, or equal.

5. Pilot Devices

a. Pilot devices consisting of pushbuttons, selector switches, pilot lights, and incidental items shall be as manufactured by Allen-Bradley, Eaton/Cutler Hammer, or Schneider/Square D (no substitutes).

b. Pilot devices shall be suitable for mounting on MCCs, switchgear, control panels, and control stations. Pilot devices shall be 30.5 mm, NEMA Type 4/13 with cast metal bases, chrome-plated octagonal mounting nuts, and legend plates.

c. Pushbuttons and switch knobs shall be heavy duty plastic. Unless indicated otherwise on the Drawings, switch knobs shall be black and pushbuttons shall colors shall be as follows:

<table>
<thead>
<tr>
<th>Color</th>
<th>Function</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Emergency Stop, Stop, Off</td>
<td>Emergency Stop button, Master Stop button, Stop of one or more motors</td>
</tr>
<tr>
<td>Yellow (Amber)</td>
<td>Return, Emergency Return, Intervention (suppress abnormal conditions)</td>
<td>Return of machine to safe position, override other functions previously selected</td>
</tr>
<tr>
<td>Green</td>
<td>Start-On</td>
<td>General or machine start. Start of cycle or partial sequence.</td>
</tr>
<tr>
<td>Black</td>
<td>No specific function assigned</td>
<td>Permitted to be used for any function except for those listed above.</td>
</tr>
</tbody>
</table>

d. Contact blocks shall have AC contact ratings of NEMA A600, 10 A with silver contacts for corrosion resistance and clear side plates for contact inspection.
e. Pilot light devices shall be push-to-test type and shall be provided with LEDs and transformers suitable for operation on 120 VAC power. Pilot light lenses shall be shatter resistant plastic. Unless indicated otherwise on the Drawings, pilot light lens colors shall be as follows:

<table>
<thead>
<tr>
<th>Color</th>
<th>Function</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Fail or Alarm (abnormal condition requiring immediate attention)</td>
<td>Indication that a protective device has stopped the machine, e.g. overload</td>
</tr>
<tr>
<td>Yellow (Amber)</td>
<td>Warning (marginal condition, change or impending change of conditions)</td>
<td>Some value (e.g. pressure) is approaching its permissible limits. Overload permitted for a limited time. Ground fault indication.</td>
</tr>
<tr>
<td>White</td>
<td>Normal Condition, Confirmation</td>
<td>Normal pressure. Control power on.</td>
</tr>
</tbody>
</table>

f. Where MCC control pushbuttons, switches and lights are shown on the Drawings, each motor control unit shall be provided with a hinged/removable control station plate, suitable for accommodating a minimum of three (3) 30.5 mm pilot devices. Additional pilot devices, where shown, shall be located on the control unit door. Manufacturer shall confirm the location of the pilot devices with the District prior to commencing equipment fabrication.

6. Power Meter

a. The power meter shall be UL listed. The meter shall be designed for multifunction electrical measurement on three-phase power systems. The meter shall perform as specified in harsh electrical applications in high and low voltage power systems.

i. The meter shall support 3 element wye, 2.5 element wye, 2 element delta, and 4 wire delta systems.

ii. The meter shall accept universal voltage input.

iii. The meter shall be user programmable for voltage range to any potential transformer ratio.
The meter shall use a dual input method for current inputs. One method shall allow the current transformer (CT) to pass directly through the meter without any physical termination on the meter, ensuring the meter cannot be a point of failure on the CT circuit. The second method shall provide additional termination pass-through bars, allowing the CT leads to be terminated on the meter. The meter shall support both termination methods.

i. Fault current withstand shall be 100 A for 10 seconds, 300 A for 3 seconds, and 500 A for 1 second.

ii. The meter shall be programmable for current to any CT ratio. DIP switches or other fixed ratios shall not be acceptable.

iii. All inputs and outputs shall be galvanically isolated to 2500 VAC.

iv. The meter shall accept current inputs of Class 10: 0 to 10 A (5 A nominal), and Class 2: 0 to 2 A (1A nominal) secondary.

c. The meter shall have an accuracy of +/- 0.1% or better for voltage and current, and 0.2% for power and energy functions. The meter shall have a frequency measurement accuracy of not less than 0.001 Hz.

i. The meter shall provide true RMS measurements of voltage (phase-to-neutral, phase-to-phase) and current (per phase and neutral).

ii. The meter shall calculate RMS readings, sampling at over 400 samples per cycle on all channels measured readings continuously with no cycle blind spots.

iii. The meter shall provide voltage and current distortion measurements (% of total harmonic distortion). Harmonic magnitude recording to the 40th order shall be available for voltage and current harmonics.

d. The meter shall be capable of simultaneously recording voltage and current waveforms.

i. The meter shall be capable of recording 512 samples per cycle for a voltage sag or swell or a current fault event.

ii. The meter shall provide pre-event and post-event recording capability.

iii. The meter shall allow up to 170 events to be recorded.

e. The meter shall be suitable for flush door mounting. The meter shall be provided with a three-line, LED display. The meter shall display a percent of load bar on the front panel. The percent of load bar shall have not less than 10 segments.
f. The meter shall be a traceable revenue meter, which shall contain a utility grade test pulse allowing power providers to verify and confirm that the meter is performing to its rated accuracy.

g. Power meter shall include virtual measurement upgrade packs, which shall allow field upgrades without removing the installed meter.

i. As a minimum, the meter shall be provided with an upgrade pack that provides multifunction metering consisting of: volts, amps, kW, kVAR, PF, kVA, frequency, kWh, kVAh, kVARh, and I/O expansion.

ii. The meter shall be provided with 2 MB of memory for data logging.

h. The meter shall include 2 independent communications ports on the back and face plate, with advanced features. The back plate communication port shall provide RS485 communication in Modbus protocol. The face plate communication port shall be an optical IrDA port (through faceplate), which shall allow the unit to be set up and programmed using a handheld device or remote laptop without need for a communication cable.

i. The meter shall provide a user configured fixed window or rolling window demand for a variable user utility demand profile. The meter shall provide an update rate of every 6 cycles for watts, VAR and VA. All other parameters shall be updated every 60 cycles.

j. The meter shall support a power supply of 90 to 265 VAC and 100 to 370 VDC, and shall have a burden of less than 11VA.

k. The meter shall have data logging capability with 2 MB memory. The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created. The meter shall be capable of maintaining six logs:

i. The meter shall have three historical logs for trending profiles. Each log shall be capable of being programmed with up to 64 parameters. The user shall have the ability to allocate memory between the three historical logs in order to increase or decrease the memory allotted to each of the logs.

ii. The meter shall have a log for limits alarms. The limits log shall provide magnitude and duration of an event, time-stamp, and log value. The log must be capable of recording to 2048 events.
iii. The meter shall have a log for system events. The system events log shall record the following occurrences with a time-stamp: demand resets, password requests, system startup, energy resets, log resets, log reads, programmable settings changes.

iv. The meter shall have a log for I/O changes. The I/O change log shall provide a time-stamped record of any relay outputs and any input status changes. The log must be capable of recording up to 2048 events.

l. The meter shall have I/O expandability through two option card slots on the back. The meter shall auto-detect the presence of any I/O option cards. The meter shall be furnished with an option card that provides four pulse outputs and 4 status inputs.

m. The pulse output/digital input option card shall provide the following features:

i. 4 KYZ pulse/4 status inputs.
ii. Programmable to any energy parameter and pulse value.
iii. Programmable to end of interval pulse.
iv. 120mA continuous load current.
v. DNP input.

n. The power meter shall be rated NEMA Type 12, and shall be capable of operating in ambient temperatures of -20 to +70°C. The meter shall have a standard 4-year warranty. The power meter shall be Electro Industries/Gauge Tech Model Shark 200-60-10-V1-D2-PO1S-X (no substitutes).

N. Lighting Panelboards and Transformers

Lighting panelboards and transformers shall be as specified in Part 2.03 herein and as indicated on the Drawings.

O. Heating and Ventilation

Heating and ventilation shall be as designed by the manufacturer, and shall comply with the requirements specified herein and indicated on the Drawings. MCCs shall be equipped with heating and ventilation equipment and components as specified herein, and in accordance with the manufacturer’s design requirements.
1. **MCCs Located Indoors**

Unless indicated otherwise on the Drawings, MCCs located indoors shall be provided with NEMA 1A, gasketed enclosures. As a minimum, MCC NEMA 1A enclosures shall comply with the following heating and ventilation requirements:

   a. All MCC sections, except sections with bottom feed main lugs, bottom feed mains and branches over 600 A, and lighting panel transformers, shall be provided with space heaters to prevent condensation. Space heaters shall operate on 120 V, 60 Hz power. Line voltage thermostats shall be provided for controlling the space heaters. The thermostats shall monitor the temperature inside the NEMA 1A enclosures with temperature adjustment accessible from the outside face of the enclosures.

   b. Unless specified otherwise, MCC sections equipped with variable frequency drives or soft starters, shall be provided with forced air ventilation cooling as required to maintain the ambient temperature for the housed equipment to no greater than its maximum ambient temperature rating for continuous operation at full rated capacity.

   c. Forced air ventilation shall be provided with supply fans mounted at the bottom of the enclosure doors. The bottom door fans shall force fresh air into the enclosure through ventilation louvers located at the bottom of the doors to create a positive internal air pressure; and thereby, forcing out dirt and contaminants, and moving warm air out through ventilation louvers located at the top of the doors. A factory installed thermostat shall control the fans based on the MCCs internal temperature; or alternatively, fan operation shall be controlled by “run” operation of the variable frequency drive or soft starter. Door interlock switches shall be provided to turn the fans off when the door is opened. Unless specified otherwise, each ventilation louver (top and bottom) shall be covered by an air filter. Air filters shall be washable aluminum mesh type, gasketed on all sides, and removable (without the use of tools) for cleaning.

   d. Control power transformers with primary and secondary fuse protection shall be provided as required for proper operation of the enclosure heating and ventilating equipment, unless Drawings show otherwise. Supply voltage shall be 120 V, 60 Hz. The control power transformers shall be prewired at the factory to all fans, space heaters, and temperature controls. Separate line voltage thermostats shall be provided for heating and cooling.
2. **MCCs Located Outdoors**

Unless indicated otherwise on the Drawings, MCCs located outdoors shall be provided with NEMA 3R, non-walk-in enclosures. Heating and ventilation requirements for MCC NEMA 3R, non-walk-in enclosures shall be in addition to the requirements specified above for NEMA 1A enclosures. As a minimum, MCC NEMA 3R enclosures shall be comply with the following heating and ventilation requirements:

a. All heating and ventilation requirements for NEMA 1A, gasketed enclosures specified above shall apply for the interior MCC sections.

b. Where NEMA 1A enclosures are provided with fans for ventilation, NEMA 3R wrapper doors shall be provided with supply fans mounted at the bottom of the enclosure doors. The bottom door fans shall force fresh air into the vestibule space between the wrapper doors and NEMA 1A enclosure to create a positive internal air pressure; and thereby, forcing out dirt and contaminants, supplying fresh air to interior MCC sections, and moving warm air out through ventilation louvers located at the top of the doors. NEMA 3R wrapper line voltage thermostats (separate from the MCC cooling thermostats) shall control the outer door mounted fans based on the temperature in the vestibule space; or alternatively, fan operation shall be controlled by “run” operation of the variable frequency drive or soft starter. Door interlock switches shall be provided to turn the fans off when the outer doors are opened.

c. Heating shall consist of the space heaters and thermostats specified above for the NEMA 1A enclosure. No additional heating is required for the NEMA 3R wrapper.

d. Openings for supply air and exhaust air in NEMA 3R wrapper doors shall be provided with integral louvers or weatherproof hoods as specified herein.

e. Heating and ventilation shall be as designed by the manufacturer, and shall comply with the requirements specified herein and indicated on the Drawings. If the NEMA 3R wrapper is fabricated by a third party manufacturer, the MCC manufacturer shall review the ventilation design and certify in writing that the proposed ventilation system is properly designed and the MCC manufacturer’s warranty for the MCC equipment is in full effect.
Control power transformers with primary and secondary fuse protection shall be provided as required for proper operation of the NEMA 3R wrapper fans and thermostats, unless Drawings show otherwise. Supply voltage shall be 120 V, 60 Hz. The control power transformers shall be prewired at the factory to all fans and temperature controls.

2.02 SWITCHBOARDS

A. General

1. Service and distribution switchboards shall be 600 V class suitable for operation on a three-phase, 480 V, 60 Hz system. Switchboards shall be configured for 3-wire or 4-wire systems, as indicated on the Drawings. Switchboards shall be manufactured by Eaton/Cutler-Hammer, Schneider Electric/Square D, or General Electric (no substitutes).

2. Switchboards shall be manufactured in compliance with UL 891 and shall be UL labeled.

3. Switchboard amperage ratings, including all devices, shall be based on a maximum ambient temperature of 40°C per UL Standard 891. With no de-rating required, temperature rise of switchboards and devices shall not exceed 65°C in a 40°C ambient environment. Where specified, switchboards and devices shall be suitable for operation in a 50°C ambient environment with the appropriate de-rating factors incorporated into the equipment design as certified by the manufacturer.

B. Structure

1. Switchboards shall be front accessible with fixed individually mounted or drawout mounted main protective devices and fixed individually mounted or panel mounted bolt-on protective devices.

2. Switchboards shall be fully self-supporting structures with 90 inch (nominal) tall vertical sections (excluding lifting eyes and pull boxes) bolted together to form the required arrangement.

3. Switchboard frame shall be die formed, 12 gauge (minimum) steel with reinforced corner gussets. Frame shall be rigidly bolted to support cover plates (code gauge steel), bus bars and installed devices during shipment and installation. All covers shall be attached with hex head bolts.
4. Switchboards shall be capable of being bolted directly to a concrete floor or slab without the use of floor sills. All switchboard sections shall have open bottoms and removable top plate(s) to install conduit as shown on the Drawings.

5. Front covers shall be screw removable with a single tool and doors shall be hinged and provided with removable hinge pins. All edges of front covers shall be formed.

6. Unless indicated otherwise herein or on the Drawings, the incoming pull section shall be bussed. Incoming cable entry into the pull section shall be as shown on the Drawings.

7. Distribution sections shall be bussed and shall be matched and aligned with the basic switchboard. Bus transition and incoming cable pull sections shall be matched and aligned with the basic switchboard.

8. Barriers shall be provided between adjacent switchboard sections. A vertical insulating barrier shall be provided between the incoming cable pull section and the main bus to protect against inadvertent contact with main or vertical bus bars. Through-busing shall be taped to provide insulation and isolation.

9. Service switchboard shall be suitable for use as service entrance equipment. Service switchboard incoming pull section, and utility metering compartment and section shall be fabricated in accordance with utility company's requirements and UL service entrance requirements, including UL service entrance label, incoming line isolation barriers, and removable neutral bond to switchboard ground for solidly grounded wye systems. If a separate vertical section is required for utility metering, it shall be matched and aligned with the basic switchboard.

10. Where indicated on the Drawings, switchboard shall be provided with top mounted pull box. Adequate ventilation shall be provided to maintain temperature in pull box within the same limits as the switchboard. Bottom of pull box shall be constructed of insulating, fire-resistive material with separate holes for cable drops into switchboard.

11. The switchboard assembly shall be provided with adequate lifting means (e.g. lifting eyes or lifting bars).

C. Buses

1. All bus bars shall be hard-drawn tin-plated copper of 98 percent conductivity. Plating shall be applied continuously to bus work.
2. The phase through-busing shall have a minimum ampacity as indicated on the Drawings. The main incoming bus bars shall be rated for the same ampacity as the through-busing. For four-wire systems, the neutral bus shall be of equivalent ampacity as the phase bus bars. Tapered bus is not permitted. Busing shall be of sufficient cross-sectional area to meet UL 891 temperature rise requirements. Plating shall be applied continuously to bus work.

3. Ground bus shall be sized per NEC and UL 891 Tables 28.1 and 28.2. Ground bus shall be firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

4. Where indicated on the Drawings, full provisions for the addition of future sections shall be provided. Bussing shall include, but not be limited to, all necessary hardware to accommodate splicing for future additions.

5. Where indicated on the Drawings, equip compartments designated for future protective devices with mounting brackets, supports, bus connections, and appurtenances at the full rating of the future device. Compartments for future devices shall be provided with all necessary straps, hardware, and filler plates to completely cover the openings.

6. Isolation barriers shall be configured to permit access to busing for verification of bus bolt torque.

7. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

8. The bus system shall be rated for an available short-circuit capacity of not less than 65,000 RMS amperes. If the results of the Contractor’s Electrical Short-circuit and Protective Device Evaluation and Coordination Study, as accepted by the District, indicate that a higher short-circuit duty rating of the switchboard is required, Contractor shall furnish the switchboard with that higher rating.

D. Instrument Transformers

1. All instrument transformers shall be UL listed.

2. Current transformers shall be provided with ratios, accuracy class and burden to support connected meters, relays and instruments, as required by ANSI/IEEE C57.13.
3. Potential transformers shall be provided with secondary voltage rating of 120 V (unless specified otherwise) and shall be provided with burden and accuracy to support connected meters, relays and instruments, as required by ANSI/IEEE C57.13.

4. Control power transformers shall be dry type and mounted in separate compartments for units larger than 3 KVA.

5. Where current transformers for neutral and ground fault current sensing are required, connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker (where specified). Coordinate with feeder circuit breaker ground fault protection.

E. Control Power

1. Control Circuits: 120 volts, supplied through secondary disconnecting devices from control power transformer.

2. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

F. Wiring and Terminations

1. Copper compression type lugs shall be provided for all line and load terminations, and shall be suitable for copper cable rated for 75°C of the size as indicated on the Drawings.

2. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors, including branch circuit ground conductors, shall be provided as indicated on the Drawings.

3. Where fine stranded conductors, Class C and higher (such as DLO cable) are utilized for internal wiring, all terminations in mechanical lugs shall be provided with copper flex-cable compression adapters to properly confine the fine strands and prevent overheating of the connection and wire pullout from lugs. The flex-cable compression adapters shall fit mechanical set-screw mechanical lug type connectors and shall be sized for the full current carrying capacity of the cable. The adapters shall be provided a flared barrel-opening to allow easy cable insertion. The adapter shall be constructed of wrought copper with pin of Class B stranded copper conductor, rated for 600V and 105°C cable, and shall be UL listed. Pin length shall be sufficient to allow full engagement into the mechanical lug. Flex-cable copper compression adapters shall be Shoo-pin PT-FX Series, as manufactured by Greaves Corporation, or equal.
4. Control wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control wiring shall be factory installed with bundling, lacing and protection included. Factory control wiring shall include conductors for interconnections between shipping units.

5. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer’s wiring diagrams.

6. All control wire shall be bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle-type terminals provided are integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

7. Control wires connected to door mounted components shall be tied and bundled in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall allow the door to swing full open without undue stress or abrasion. Bundles shall be held on each side of hinge by mechanical fastening devices.

G. Enclosures

1. Switchboards Located Indoors

Unless indicated otherwise on the Drawings, switchboards located indoors shall be provided with free standing NEMA Type 1 enclosures. As a minimum, switchboard NEMA 1 enclosures shall comply with the following requirements:

a. Enclosures shall be provided in accordance with UL 891 requirements. Each enclosure shall be adequately ventilated to limit the temperature rise of the switchboard and all devices to 65°C in a 40°C ambient environment. Top and bottom conduit areas shall be clearly indicated on the shop drawings.

b. Ventilation openings shall be covered by interior mounted air filters. Air filters shall be washable aluminum mesh type and shall be removable (without the use of tools) for cleaning.
2. Switchboards Located Outdoors

Unless indicated otherwise on the Drawings, switchboards located outdoors shall be provided with NEMA Type 3R, non-walk-in (rainproof) enclosures. Switchboard NEMA Type 3R, non-walk-in enclosures shall be based on free standing NEMA Type 1 enclosures with a NEMA 3R wrapper. The additional housing supplied by the NEMA 3R wrapper shall provide protection from rain, sleet, and ice. As a minimum, switchboard NEMA Type 3R, non-walk-in enclosures shall comply with the following requirements:

a. The enclosing NEMA 3R wrapper shall be constructed of 12 gauge galvanneal steel with a flat or sloped roof line. Sloped roof lines shall be sloped from front to rear at a minimum of 1/2 inch per foot. Doors shall be louvered and hooded at top and bottom, and gasketing shall be provided around four door closing flanges.

b. Each NEMA 3R wrapper split or section shall have a minimum of 30 inches working clearance from hinge flange to door closure flange. The width of open unobstructed area when door is open shall be 30 inches minimum.

c. NEMA 3R wrapper splits shall be coordinated with the switchboard section splits. Cabinet spacers shall be provided at switchboard section splits to permit full opening (90 degrees, minimum) of all switchboard doors without interfering with the NEMA 3R wrapper doors. Switchboard shall be provided with all cabinet spacers, through-bus splice kits, neutral bus splice kits, and ground bus splice kits required to interconnect switchboard sections and provide the necessary separation for switchboard doors to fully open.

d. The distance between the front of the interior switchboard section and the outer doors shall be 11 inches, minimum.

e. Interior lighting shall be provided in the NEMA 3R wrapper vestibule using LED lighting fixtures, single-tube, with length as necessary for width of NEMA 3R wrapper split. A light switch shall be provided on side extension for each switchboard shipping split, and shall be furnished with a stainless steel cover plate.

f. Convenience receptacles shall be provided for each switchboard shipping split, and shall be duplex GFCI type, with stainless steel cover.
g. All switchboard sections, except pull sections, shall be provided with
space heaters. Space heaters shall be provided with adequate wattage to
prevent condensation. Space heaters shall be installed within the NEMA
1 switchboard sections and shall operate on 120 V, 60 Hz power. Line
voltage thermostats shall be provided for controlling the space heaters.
The thermostats shall monitor the temperature inside the NEMA 1
enclosures with temperature adjustment accessible from the outside face
of the enclosures.

h. NEMA 3R wrapper doors shall be provided with ventilation openings as
required for proper cooling of the switchboard and devices. As a
minimum, each ventilation opening shall be provided with louvers
integrated molded into the door and covered by interior mounted air
filters with gasketing. Air filters shall be washable aluminum mesh type
and shall be removable (without the use of tools) for cleaning. Alternatively, ventilation openings in doors may be clear openings
covered by exterior weatherproof hoods. Openings shall be provided
with washable air filters as specified above. In addition, openings at the
bottom of the hoods shall be provided with removable insect screens.

i. Heating and ventilation shall be as designed by the manufacturer, and
shall comply with the requirements specified herein and indicated on the
Drawings. If the NEMA 3R wrapper is fabricated by a third party
manufacturer, the switchboard manufacturer shall review the ventilation
design and certify in writing that the proposed ventilation system is
properly designed and the switchboard manufacturer’s warranty for the
switchboard equipment is in full effect.

j. NEMA 3R wrapper front door handles shall have provisions for padlocking
and shall be equipped with wind stops.

k. Control power transformers shall be provided within the switchboard to
supply power to the space heaters, interior lighting, and receptacles.
Control power transformers shall be equipped with primary and
secondary fuse protection. Supply voltage shall be 120 V, 60 Hz. The
control power transformers shall be prewired at the factory to all space
heaters, temperature controls, interior lighting, and receptacles.

H. Finish

1. All steel parts shall be provided with UL listed acrylic/alkyd baked enamel paint
finish or TGIC Powder Coat, except plated parts used for ground connections. All
painted parts shall undergo a multi-stage treatment process, followed by the
finishing paint coat.
2. Pre-treatment shall include:
   
   a. Hot alkaline cleaner to remove grease and oil.
   
   b. Iron phosphate treatment to improve adhesion and corrosion resistance.

3. The paint shall be applied using an electro-deposition process to ensure a uniform paint coat with high adhesion.

4. The standard paint finish shall be tested to UL 50 per ASTM B117 (5% ASTM Salt Spray) with no greater than 0.125 inch loss of paint from a scribed line.

5. Paint color for switchboard NEMA 1 enclosures shall be #49 medium light gray per ANSI Standard Z55.1 (60-70 gloss) on all surfaces, unless specified otherwise.

6. Paint color for switchboard NEMA 3R enclosures (NEMA 3R wrappers) shall be white (60-70 gloss) on all surfaces, unless specified otherwise.

I. Protective Devices

1. Switchboard protective devices shall be furnished as indicated on the Drawings and specified herein, including interconnections, instrumentation and control wiring.

2. Main protective devices shall be fixed individually mounted or drawout mounted. Branch protective devices shall be fixed individually mounted or group mounted with bolted connections.

3. Protective devices shall be provided with frame sizes as indicated on the Drawings. Protective devices with frame sizes less than or equal to 2000 A shall be molded case circuit breakers as specified in Part 2.04D, herein. Unless specified otherwise, protective devices with frame sizes greater than 2000 A shall be insulated case power circuit breakers as specified in Part 2.04E herein. The short-circuit current rating of the protective devices shall be greater than or equal to the switchboard bus rating.
J. Utility Metering and Main Disconnect

1. Main Service Switchboard

Where indicated on the Drawings, main service switchboard shall consist of pull section, utility service (metering) section, and main protective device. Main service switchboard shall be provided in accordance with the requirements specified herein and as indicated on the Drawings.

Equipment shall include a separate, barriered-off, utility metering compartment complete with hinged sealable door as approved by the utility company. Bus work shall include provisions for mounting utility company current transformers, potential transformers, potential taps, test devices, and metering as required by the utility company. Switchboard neutral to ground bonding connection shall be in accordance with utility company requirements. Provide Service Entrance Label and provide necessary applicable service entrance features per NEC, local code requirements, and utility company requirements.

All electrical service equipment shall be in strict accordance with utility company requirements and requirements specified herein. In cases of conflict between the requirements specified herein and the requirements of the utility company, the more stringent requirement shall prevail. Prior to commencing fabrication of electrical service equipment, Contractor shall submit shop drawings of proposed equipment to utility company and District for review and approval.

2. Main Protective Device

Main protective device shall be a molded case circuit breaker or insulated case power circuit breaker as specified in Part 2.04 herein. Circuit breaker shall be provided with a microprocessor-based RMS sensing trip unit, and shall be equipped with ground fault protection and arc-flash reduction maintenance system. Circuit breaker frame size and shall be as indicated on the Drawings. Circuit breaker short-circuit current rating shall be greater than or equal to the switchboard bus rating.

Main circuit breaker shall be equipped with ground fault protection and arc-flash reduction maintenance mode and be capable of remote operation via a switch located in the MCC.

2.03 LIGHTING PANELBOARDS AND TRANSFORMERS

A. Manufacturers

Lighting panelboards and transformers shall be manufactured by Eaton/Cutler-Hammer, Schneider/Square D, or General Electric (no substitutes).
B. **General**

1. Lighting panelboards mounted in MCCs shall be constructed integrally with the MCC and shall match the finish of the MCC. Lighting panelboards, branch circuit breakers, and transformers mounted in MCCs shall meet the applicable requirements specified herein.

2. Standalone lighting panelboards and transformers shall be provided in accordance with the requirements specified herein. Standalone lighting panelboards shall be suitable surface mounting or flush mounting as indicated on the Drawings.

C. **Ratings**

1. 240 V lighting panelboards shall be rated to withstand a minimum fault current of 22,000 amperes symmetrical, unless a higher fault current is indicated on the Drawings or determined by Contractor’s Electrical Short-circuit and Protective Device Evaluation and Coordination Study.

2. Equipment shall meet both UL891 and UL67 thermal standards.

D. **Interior**

1. Panelboard interiors mounted in MCCs shall be flush mounted with the front of the enclosure to allow easy access to line and/or load conductors entering/exiting top or bottom. Recessing the panel interior more than 3 inches from the front of the enclosure will not be acceptable.

2. Panelboard interior shall be compartmentalized with steel walls on all four sides. Panelboard shall be sized to provide a minimum of 4 inches of gutter space on all sides.

3. Panelboard main breakers shall be integral to the panel interior. Main breakers separate from the interior will not be acceptable.

4. Provide one continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing shall be plated copper. Aluminum bussing will not be acceptable. Bus bar plating shall run the entire length of the bus bar.

5. Current carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
6. Panelboard shall be provided with a solidly bonded, plated copper, equipment ground bar(s). Ground bar(s) shall be adequate for terminating ground conductors for the maximum number of panel circuits.

7. Panelboard shall be provided with full size neutral bars with suitable lugs for the maximum number of panel circuits. Neutral bars with shall be plated copper and shall be located in the main compartment so incoming neutral cable may be of the same length.

8. Panelboard interior shall be provided with nameplates containing system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL-listed label, and short-circuit current rating shall be displayed on the interior.

E. Fronts

1. Trim front shall one-piece, bolt-on type with door, and shall meet strength and rigidity requirements of applicable UL 50 standards. Door shall have rounded corners and edges free of burrs.

2. Interior trim shall be of deadfront construction to shield user from energized parts. Deadfront trim shall have filler plates covering unused circuit breaker mounting spaces.

3. Fronts for NEMA Type 1 enclosures shall have flush cylindrical tumbler lock with catch and spring-loaded stainless steel door pull. All lock assemblies shall be keyed alike. Two keys shall be provided with each lock. Front shall not be removable with the door locked.

4. A clear plastic directory cardholder with typed circuit directory shall be mounted on the inside of the door. Adhesive circuit directories are not acceptable.

F. Enclosures

1. Enclosures for lighting panelboards mounted in MCCs shall be constructed integrally with the MCC enclosure.
2. Enclosures for standalone lighting panelboards shall be provided in accordance with the following:

   a. Enclosures shall be constructed of galvannealed steel with a ANSI #49 gray enamel electrodeposited over cleaned phosphatized steel. Enclosures shall be constructed in accordance with UL 50 and 50E requirements.

   b. Unless indicated otherwise on the Drawings, indoor enclosures shall be NEMA Type 1 gasketed, and outdoor enclosures shall be NEMA Type 3R gasketed.

   c. Outdoor NEMA Type 3R enclosures shall be provided with a padlockable hasp to secure the door.

G. **Main Circuit Breaker**

1. Main circuit breakers for lighting panelboards shall be molded case thermal-magnetic circuit breakers. Circuit breakers shall be provided with inverse time-current elements for low-level overloads and instantaneous magnetic trip elements for short-circuits. Circuit breakers shall be UL listed with amperage ratings and number of poles as indicated on the Drawings.

2. Main circuit breaker interrupting rating shall be selected to match the lighting panelboard short-circuit current rating (minimum 22,000 RMS symmetrical amperes).

3. Main circuit breaker shall have an over-center, trip-free, toggle mechanism which shall provide quick-make, quick-break contact action. Circuit breaker shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true RMS sensing and shall be factory calibrated to operate in a 40°C ambient environment. Thermal elements shall be ambient compensating above 40°C.

4. Two-pole and three-pole circuit breakers shall have common tripping of all poles. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker that shall allow the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.

5. Circuit breaker handle and faceplate shall indicate rated ampacity. Circuit breaker shall be provided with handle accessories for locking handle in the off position.
6. Circuit breaker lugs shall be UL-listed to accept solid or stranded copper conductors only. Lug sizes shall be based on conductor amperages corresponding to those shown in NEC Table 310-16 for 75°C rated wire.

7. Circuit breakers shall be bolted-on type. Snap-in designs are not acceptable.

8. Main circuit breakers shall be UL-listed for use with the following factory installed accessories: shunt trip, under voltage trip, ground fault trip, auxiliary switch, alarm switch, and mechanical lug kits. Main circuit breaker accessories shall be provided as indicated on the Drawings.

H. Branch Circuit Breakers

1. Branch circuit breakers for lighting panelboards shall be molded case thermal-magnetic circuit breakers. Circuit breakers shall be provided with inverse time-current elements for low-level overloads and instantaneous magnetic trip elements for short-circuits.

2. Branch circuit breakers shall be HACR type, unless specified otherwise. Breakers shall be UL-listed with amperage ratings and number of poles as indicated on the Drawings. Unless specified otherwise, minimum amperage rating for branch circuit breakers shall be 20 A, and amperage rating for spare circuit breakers shall be 20A.

3. Interrupting ratings of branch circuit breakers shall match rating of main circuit breaker.

4. Molded case branch circuit breakers shall be bolt-on type. Snap-in designs are not acceptable.

5. Circuit breakers shall have an over-center, trip-free, toggle mechanism which shall provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two-pole and three-pole circuit breakers shall have common tripping of all poles. Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductors in a 40°C ambient temperature.

6. Circuit breakers shall be provided with two forms of visible trip indication. The circuit breaker handle shall reside in a position between on and off. In addition, there shall be a red indicator appearing in the clear window of the circuit breaker housing.
7. The exposed faceplates of branch circuit breakers shall be flush with one another.

8. Ground Fault Current Interrupting (GFCI) circuit breakers shall be provided where indicated on the Drawings. GFCI circuit breakers shall be UL Class A with 30 mA sensitivity.

9. Circuit breaker lugs shall be UL-listed to accept solid or stranded copper conductors only. Lug sizes shall be based on conductor ampacities corresponding to those shown in NEC Table 310-16 for 75°C rated wire.

I. Lighting Panel Transformers

1. Transformers for lighting panels shall be energy efficient (NEMA TP-1 compliant or Energy Star labeled), dry type, and UL listed with a minimum KVA rating as indicated on the Drawings. Unless specified otherwise, transformers shall be single phase, 480 V primary and 120/240 V secondary.

2. Transformer shall be "K" rated for high harmonic loads when non-linear loads are present.

3. Transformers shall be provided with a minimum of 4 full capacity primary winding taps. Unless specified otherwise, 2 winding taps shall be provided at 2.5 percent above nominal, and 2 winding taps shall be provided at 2.5 percent below nominal.

4. Transformer insulation system shall be rated at 220°C and designed for full load operation at a maximum of 115°C temperature rise above 40°C ambient. Transformers shall be capable of carrying a 15 percent continuous overload without exceeding a 150°C temperature rise above 40°C ambient.

5. Transformer coils shall be copper continuous wound construction and shall be impregnated with non-hygroscopic thermosetting varnish.

6. Each transformer winding shall be provided with an electrostatic shield arranged to minimize inter-winding capacitance.

7. Fan cooled transformers will not be acceptable.

8. Sound level shall be warranted by the manufacturer not exceed 45 decibels measured at 5 feet from the transformer.

9. The secondary side neutral conductor of the transformer shall be factory grounded.
10. The core of the transformer shall be grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.

11. Transformers shall be factory installed in a freestanding enclosure (except for MCC applications), NEMA Type 1 for indoor locations and NEMA Type 3R for outdoor locations. Transformer enclosures shall be ventilated and fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI #49, gray.

2.04 PROTECTIVE DEVICES

A. General Requirements for Molded Case Circuit Breakers

1. Molded case circuit breakers shall be UL listed and conform to UL 489 and NEMA AB1. Molded case circuit breakers shall be as manufactured by Eaton/Cutler-Hammer, Schneider/Square D, General Electric, or approved equal.

2. Unless specified otherwise, mold case circuit breakers shall be thermal-magnetic type with inverse time-current thermal element for low-level overloads, and instantaneous magnetic trip element for short-circuits.

3. Circuit breakers shall be provided with ambient temperature compensating thermal trips for a minimum range of 10 to 50 °C.

4. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

5. Breakers specified for operation on a 480 V, 60 Hz system shall be rated for 600 V and shall have a minimum symmetrical interrupting capacity of 65,000 A. Breakers shall be provided with a higher interrupting capacity, if indicated on the Drawings or required by the Contractor’s Electrical Short-circuit and Protective Device Evaluation and Coordination Study.
6. Circuit breaker amperage rating shall be as required to protect the specified branch circuit and equipment. Contractor shall coordinate circuit breaker amperage rating with actual equipment to be furnished. Minimum circuit breaker amperage rating shall be as indicated on the Drawings.

7. Contractor shall coordinate the applicable circuit breaker sensor, trip unit, and rating plug with the required amperage rating.

8. Where indicated on the Drawings, circuit breakers shall be UL listed for application in their intended enclosures at 100% of their continuous ampere rating.

9. Ground fault protection shall be provided where indicated on the Drawings.

10. Where indicated on the Drawings, circuit breakers shall be current limiting.

11. Unless specified otherwise, circuit breaker load connections shall be compression style, suitable for copper conductors of the number, size, and type indicated on the Drawings.

B. Molded Case Circuit Breakers with Non-Interchangeable Trip Units

1. Unless specified otherwise, circuit breakers with 100 A frames and below shall be provided with factory installed non-interchangeable trip units.

2. Unless specified otherwise, circuit breakers with non-interchangeable trip units shall be provided with fixed magnetic trip elements.

C. Molded Case Circuit Breakers with Interchangeable Trip Units

1. Unless specified otherwise, circuit breakers with 225 A to 600 A frames shall be provided with interchangeable trip units. Trip units shall be field interchangeable. Factory interchangeable trip units are not acceptable.

2. Circuit breaker magnetic trip element shall be provided with front-mounted, field adjustable trip setting. As a minimum, the adjustable magnetic trip shall provide high, low, and intermediate trip settings.
D. Molded Case Circuit Breakers with Solid-State Trip Units

1. Unless specified otherwise, circuit breakers identified on the Drawings as “main circuit breakers” (located in the main service switchboard, distribution switchboards, or MCCs), or circuit breakers with 800 A frames and above shall have solid-state trip units. In addition, the “main circuit breaker” located in the main service switchboard shall be equipped with ground fault protection.

2. As a minimum the solid-state trip units shall be provided with the following components, features, and capabilities:

   a. Microprocessor-based trip device, flux-transfer shunt trip, and three (3) integral current sensors. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors, and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached. The trip unit shall be Eaton type Digitrip 310, General Electric type MicroVersaTrip Plus, or approved equal.

   b. An adjustable trip setting dial mounted on the front of the trip unit and interchangeable ratings plugs shall establish the continuous trip ratings of each circuit breaker as a function of the rating plug amperage. Rating plugs shall be field interchangeable. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.

   c. As a minimum, system coordination shall be provided by the following microprocessor-based time-current curve shaping features: adjustable long-time setting and delay, adjustable short-time setting and delay, adjustable instantaneous pick-up, adjustable instantaneous setting (pick-up), and where specified, adjustable ground fault setting and delay.

   d. The microprocessor-based trip unit shall have both powered and unpowered thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

   e. When the adjustable instantaneous setting is omitted, the trip unit shall be operate with an instantaneous override.
f. Where internal ground fault protection is specified, adjustable settings shall not exceed 1200 A. Provide neutral ground fault sensor for four-wire loads.

g. Breakers shall have built-in jack located on the front to accept a test cable from a test kit. Provide one portable, battery operated test kit capable of testing all breakers 225 A frame and above. The test kit shall test the circuit breaker while the circuit breaker is carrying load, and shall provide either a trip or no trip test. The test kit shall simulate a time-over current condition for the long-time, short-time and ground fault functions. The test kit shall also read trip unit switch settings and provide a report of the trip unit self-test feature.

h. Where specified herein or indicated on the Drawings, the trip unit shall be provided with an arc-flash reduction maintenance system capability. The arc-flash reduction maintenance system shall allow the operator to enable a maintenance mode using a keyed switch which enables a preset accelerated instantaneous override to reduce arc-flash energy. A LED light on the trip unit shall indicate the trip unit is in the maintenance mode.

E. Insulated Case Power Circuit Breakers

1. Unless specified otherwise, circuit breakers with frame ratings greater than 2,500 A, shall be insulated case power circuit breakers. Insulated case power circuit breakers shall be drawout type. Insulated case power circuit breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

2. Unless specified otherwise, insulated case power circuit breakers shall be electrically operated. To facilitate lifting, the insulated case circuit breaker shall have integral handles on the side of the breaker.

3. Electrically operated breakers shall be complete with close/open pushbuttons, plus red and green status lights to indicate breaker contact position, and 120 VAC motor operators. The AC source shall be supplied by a control power transformer internal to the panel assembly.
4. Breakers shall have a minimum symmetrical interrupting capacity of 65,000 A at 600 V. Breakers shall be provided with a higher interrupting capacity, if indicated on the Drawings or required by the Contractor’s Electrical Short-circuit and Protective Device Evaluation and Coordination Study. To ensure a selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to 18 times their frame ratings. Insulated case circuit breakers without an instantaneous trip element adjustment shall be equipped with a fixed internal instantaneous override set at that level.

5. All insulated case power circuit breakers shall be constructed and tested in accordance with UL requirements, and shall carry a UL label.

6. Each insulated case circuit breaker shall be equipped with a solid-state trip unit. As a minimum the solid-state trip unit shall be provided with the following components, features, and capabilities:

   a. Microprocessor-based trip device, flux-transfer shunt trip, and three current sensors. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The trip unit shall be Eaton type Digitrip RMS 520, or equal.

   b. The trip unit shall be provided with individually adjustable time/current curve shaping solid-state elements for protective device coordination, and shall, as a minimum, include: long delay pickup and time, short delay pickup and time, and instantaneous pickup. Unless specified otherwise, trip units provided on insulated case circuit breakers in main service switchboards shall be provided with ground fault protection, including adjustable ground fault current pickup and time. The trip unit shall have provisions for a single test kit to test each of the trip functions.

   c. The trip unit shall be provided with an information system that indicates mode of trip with LEDs following an automatic trip operation. The unit shall also be equipped with a display panel that provides a representation of the time/current curve which shall indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.
d. The solid-state trip unit shall be provided with an arc-flash reduction maintenance system capability. The arc-flash reduction maintenance system shall allow the operator to enable a maintenance mode using a keyed switch which enables a preset accelerated instantaneous override trip to reduce arc-flash energy. A LED light on the trip unit shall indicate the trip unit is in the maintenance mode.

7. The insulated case circuit breaker shall have a closing time of not more than 3 cycles. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

8. The insulated case circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.

9. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a “Positive On” feature. The breaker flag will read “Closed” if the contacts are welded and the breaker is attempted to be tripped or opened.

10. The current sensors shall have a back cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug shall provide indication of the rating on the front of the trip unit.

11. A position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green). The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open.
12. Drawout breaker cells shall be equipped with drawout rails and primary and secondary disconnecting contacts. The stationary part of the primary disconnecting devices for each insulated case circuit breaker shall consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts suitably spaced shall be furnished on the insulated case circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high-pressure point contacts with uniform pressure on each finger maintained by springs.

a. The secondary disconnecting devices shall consist of plug-in connectors mounted on the removable unit and engaging floating plug-in connectors at the front of the compartment. The secondary disconnecting devices shall be gold-plated and pin and socket contact engagement shall be maintained in the “connected” and “test” positions.

b. The removable insulated case circuit breaker element shall be equipped with disconnecting contacts, wheels and interlocks for drawout application. It shall have four (4) positions: CONNECTED, TEST, DISCONNECTED and REMOVED all of which permit closing the compartment door. The breaker drawout element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell. The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall secure the breaker in the connected, test or disconnected position by preventing levering.

2.05 NAMEPLATES AND PLAQUES

A. Engraved laminated plastic nameplates shall be provided to identify MCCs, switchboards, panelboards, door mounted components, and internal components. Nameplates shall be mounted on the face of the assembly.

B. Nameplates shall be 1/16" thick with beveled edges and satin finish. Nameplates shall be provided with black background and white letters. Letters shall be a minimum of 3/16" high. Nameplates shall be fastened with round head stainless steel screws.
C. Nameplates shall be provided for each MCC and each unit compartment. MCC nameplate shall designate: name of manufacturer, system voltage, main bus rating, main bus short-circuit rating, and vertical bus rating. MCC compartment nameplates shall designate the descriptions indicated on the Drawings. Nameplates shall be provided for each pilot device or instrument mounted on the MCC compartment doors. Pilot device nameplates shall be manufacturer's standard style. Device nameplates shall designate the descriptions indicated on the Drawings.

D. Nameplates shall be provided for each switchboard and each circuit breaker and device mounted on front of the switchboard. Switchboard nameplate shall designate: name of manufacturer, system voltage, bus rating, and bus short-circuit rating. Nameplates for the branch circuit breakers shall designate the equipment fed through the breaker.

E. Nameplates shall be provided for each panelboard and transformer. Panelboard nameplate shall designate: system voltage, bus rating, and number of circuits. Transformer nameplate shall designate: primary and secondary voltage, and KVA rating.

F. All nameplates shall be approved by the District prior to fabrication. Contractor shall submit for District approval, a master nameplate spreadsheet, listing: nameplate description (each line), letter height, and nameplate dimensions.

G. A plaque displaying a mimic bus diagram shall be provided for each switchboard. The mimic bus diagram shall be a concise visual presentation of principal switchboard components and connections. The mimic bus diagram shall be arranged in single-line diagram format, using symbols and letter designations consistent with the as-built bus diagram. The mimic bus diagram shall be engraved on an anodized aluminum plaque.

2.06 SPARE PARTS AND ACCESSORIES

A. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished. Spare parts shall be properly packaged for shipment and storage, and shall be labeled with the manufacturer's part number(s).

B. As a minimum, Contractor shall furnish the following spare parts:

1. Two (2) fuses of each type and size for three-phase power.

2. Five (5) fuses of each type and size for single-phase power (including control power).

3. One (1) circuit breaker auxiliary switch of each type.

4. Two (2) operating coils for each size AC contactor.
5. Two (2) complete sets of 3-pole stationary and moving contact assemblies for each size AC contactor.

6. Three (3) contactor overload relays of each type and rating, each relay with a complete set of contact blocks.

7. One (1) spare set of heater elements for each heater rating provided.

8. Two (2) indicating light assemblies of each type.

9. One (1) control relay of each type and rating.

10. One (1) contactor auxiliary contact of each type.

11. Two (2) one quart containers of finish paint for indoor MCC and switchboard enclosures. One quart for each, if finish paint differs for MCC and switchboard enclosures.

12. Two (2) one quart containers of finish paint for the outdoor MCC and switchboard enclosures. One quart for each, if finish paint differs for MCC and switchboard enclosures.

13. 4 keys for each type of door lock and keying.

14. Portable test kit(s) for circuit breaker microprocessor trip units to test each of the trip unit functions without removal from the panel. One test kit shall be provided for each type of trip unit supplied.

15. MCC and switchboard accessory sets, including, but not limited to, tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

16. One (1) remote racking device for drawout circuit breakers.

17. One (1) portable, floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments and suitable for the largest circuit breaker furnished.
PART 3 – EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be performed in accordance with the latest version of ANSI and NEMA standards.

The MCCs and switchboards shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete MCCs and switchboards shall be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities. The wiring and control circuits shall be given a functional test at rated voltage.

B. The manufacturer shall provide three (3) certified copies of factory test reports to District for approval prior to shipment.

3.02 INSTALLATION

A. Contractor shall install all equipment in accordance with the manufacturer’s written instructions, NEC standards, requirements and standards specified herein, and as indicated on the Drawings.

B. Each assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position.

C. Contractor shall anchor MCCs and switchboards to reinforced concrete pads and floor slabs in accordance with the calculations and details prepared by the manufacturer's engineer. Anchor bolt embedment depth shall be based on the thickness of the structure slab only, and shall not include any portion of the raised concrete housekeeping pad beneath the equipment.

D. Verify the compatibility of conductor size, type, and stranding versus the power lugs furnished. Utilize correct lugs in all applications. Crimp compression lugs with manufacturer recommended tools.

E. Support incoming line conductors and outgoing load conductors to withstand the effects of a fault current. Support (brace) incoming and outgoing conductors in accordance with the manufacturer's written requirements and per NEC, including brace material and spacing.
F. Tighten all bus splices, lugs, connectors, terminals, etc. in accordance with the equipment manufacturer's published torque tightening values for same.

G. Perform all pre-energizing checks as recommended by the manufacturer, including, but not limited to, the following:

1. Verify field wiring for proper conductor sizing.

2. Verify field wiring connection points with the Drawings and manufacturer's electrical schematics.

3. Verify the integrity of all field connections, including proper torqueing of connections.

4. Verify field connections for proper spacing between adjacent phases and/or phases to ground.

5. Verify proper support (bracing) of all incoming and outgoing conductors.

6. Verify that all ground connections have been properly made, including: ground bar connections to facility grounding system, and ground conductor connections to equipment or facility grounding systems.

7. Verify that all barriers and parts that may have been removed during installation have been re-installed.

3.03 FIELD QUALITY CONTROL

A. Contractor shall provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this Section. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.

1. Rig the assembly into final location and install on level surface.

2. Check all removable circuit breakers and starter units for easy removal and re-insertion.
3. Perform insulation tests on each power phase and verify low resistance ground connection on ground bus.

4. Connect all power wiring and control wiring and verify basic operation of each starter from control power source.

5. Torque all bolted connections made in the field and verify all factory bolted connections.

6. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on record drawings. Perform startup of any solid-state starters and variable frequency drives.

3.04 FIELD ADJUSTMENTS AND TESTING

A. Contractor shall perform all equipment field adjustments and testing in accordance with the manufacturer’s written instructions and Contract Document requirements, including, but not limited to: short-circuit protective device settings, overload relay settings, timing relays, and startup and testing.

B. Contractor shall coordinate and set circuit breaker tripping sequence from main service protective device to individual motors.

C. MCCs, switchboards, and panelboards shall be tested as stipulated in the NETA testing procedures for same and as specified in Section 16010.

D. Contractor shall prepare formal field reports on all tests performed, providing a written description of each test, test values recorded, parameter limits, deficiencies, equipment adjustments, etc., and shall provide same to District for review and approval.

3.05 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the performance of field testing and the generation of any reports.

B. Manufacturer's written certification shall be provided in accordance with Section 16010.
3.06 CLEANUP

A. All parts of the electrical equipment and materials shall be left in a clean condition. Exposed parts shall be clean of dust, dirt, cement, plaster and other materials, and all oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and cleaned. Paint touch-up shall be applied to all scratches on panels and cabinets. Electrical cabinets or enclosures shall be free of spider webs.

B. Paint touch-up matching factory color and finish shall be applied to all scratches on panels and cabinets.

3.07 INSTRUCTION

After the equipment has been installed, tested, and adjusted, and placed in satisfactory operating condition, the equipment manufacturer shall provide classroom instruction to District's personnel in the use and maintenance of the equipment. Four (4) hours of instruction shall be provided unless otherwise specified. Contractor shall give the District formal written notice of the proposed instruction period at least two weeks prior to commencement of the instruction period. Scheduled training shall be at a time acceptable to the District and the manufacturer. During this instruction period, the manufacturer shall answer any questions from District personnel. The manufacturer's obligation shall be considered ended when he and the District agree that no further instruction is needed.

END OF SECTION 16480
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### SPECIFICATIONS - DETAILED PROVISIONS

Section 16950 - Custom Control Panels

**CONTENTS**

**PART 1 - GENERAL**

- 1.01 DESCRIPTION ................................................................. 1
- 1.02 RELATED WORK SPECIFIED ELSEWHERE .......................... 1
- 1.03 SUBMITTALS ...................................................................... 1
- 1.04 DESIGN AND GENERAL REQUIREMENTS ............................ 6
- 1.05 QUALITY ASSURANCE .................................................... 8
- 1.06 DELIVERY, STORAGE, AND HANDLING ............................ 9

**PART 2 - PRODUCTS**

- 2.01 MANUFACTURERS ............................................................ 10
- 2.02 MANUFACTURED ENCLOSURES ........................................ 10
- 2.03 ENCLOSURE LIGHTS AND RECEPTACLES ......................... 16
- 2.04 ENCLOSURE HEATING AND VENTILATION ......................... 16
- 2.05 CONTROL DEVICES AND COMPONENTS ............................ 18
- 2.06 MARKERS AND NAMEPLATES .......................................... 23
- 2.07 WIRING METHODS ......................................................... 25
- 2.08 SPARE PARTS ................................................................. 26

**PART 3 - EXECUTION**

- 3.01 FACTORY TESTS ............................................................ 27
- 3.02 SITE TESTS .................................................................... 28
- 3.03 CONTROL PANEL MOUNTING ......................................... 29
- 3.04 MANUFACTURER'S SERVICES .......................................... 30
PART 1 - GENERAL

1.01 DESCRIPTION

Contractor shall furnish and install custom control panels as specified herein, shown on the Drawings, and where specified in other Specification Sections.

A. Custom control panels include, but are not limited to, Unit Control Panels (UCPs), Local Control Panels (LCPs), and Programmable Logic Controllers (PLCs). Custom control panels include control panels designed and supplied by equipment manufacturers as part of packaged equipment and equipment systems.

B. The Instrumentation and Control Subcontractor (per Section 17005) shall design or review design of custom control panels and coordinate the interface between custom control panels, MCCs, other control panels, instrumentation, and District's SCADA system (including remote telemetry units, RTUs).

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. The Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the Contractor and its Subcontractors to review all sections to ensure a complete and coordinated project.

B. Related Specification Sections include, but are not limited to, the following:

1. Sections of the Specifications specifying equipment and/or systems requiring electrical power and/or control.

2. Division 16 – Electrical

3. Division 17 – Instrumentation and Controls

1.03 SUBMITTALS

All submittals shall be in accordance with the General Conditions and requirements specified herein.
A. **Shop Drawings**

Contractor shall prepare and submit complete and organized information, drawings, and technical data for all equipment and components. All drawings shall be legible and reduced to a maximum size of 11” x 17” for inclusion within the submittal. Shop drawings shall include, but not be limited to, the following:

1. Detailed Bill of Materials for all control panel hardware, and associated materials and components, listing: manufacturer's name, quantity, description, size, and catalog/part number.

2. Complete documentation for all control panel equipment and associated components, including: manufacturer's product literature, specifications, performance capabilities, features and accessories, dimensions and weights, illustrations, and data in sufficient detail to demonstrate compliance with Specification requirements. Manufacturer's literature and data shall be marked to clearly delineate all applicable information and crossing out all inapplicable information.

3. Control panel fabrication drawings (plan view, and interior and exterior elevation views) with all equipment and components clearly shown, dimensioned, and labeled. Drawings shall show the equipment and component assembly, clearances, and locations for conduits/conductors and anchor bolts. Devices shall be identified with the same marking as used on the schematic diagrams. The drawings shall include a detailed layout of all door mounted pilot devices and instruments.

4. Enclosure construction, NEMA Type, and type and gauge of materials.

5. Detailed descriptions of control panel equipment, equipment installation requirements, and heat dissipations.

6. System configuration with power circuit single line diagrams, grounding circuits, circuit breakers, and fuses.

7. Control schematics, ladder diagrams, and interconnection drawings (see Part 1.03.B herein) for additional requirements.

8. Nameplate data including the nameplate material, heights of letter and inscriptions.

9. Spare parts list as specified in this Section.
10. Manufacturer's installation instructions including receiving, handling, and storage requirements.

B. Control Diagrams

1. Schematic diagrams shall show the equipment serial number, the purchaser's drawing number, purchase order number, or similar identification which will indicate the particular equipment to which the diagrams apply.

2. Diagrams shall show all equipment and components in the electrical system including internal wiring of subassemblies. Diagrams shall clearly identify internal and external devices, and all remote contacts and signals. Show all interconnections between power sources and device elements of a particular system or equipment, and all interlocks with other equipment/systems in a manner that fully indicates the circuit function and operation. Show all panel terminal block identification numbers and all wire numbers. Show all intermediate terminations between field elements and panels. Diagrams of subassemblies may be furnished on separate sheets.

3. Identify each device by a unique number or number-letter combination.

4. Conductor Identification: Identify each conductor by a unique number, letter, or number-letter combination. Consecutive numbering is preferred. Each conductor shall have the same identification at all terminals and tie points. All conductors connected to the same terminal or tie point shall have the same identification. Where multi conductor cable is used, a color code may be used to supplement the above identification. Where color coded multi conductor cable is used for wiring identical components, such as limit switches, the color code used shall be consistent and charted on related diagrams.

5. Provide a schematic diagram for each electrical system. The schematic diagram shall be drawn between vertical lines which represent the source of control power. Show control devices between these lines. Show actuating coils of control devices on the right-hand side. Show contacts between the coils and the left vertical line.

   a. Where the internal wiring diagrams of subassemblies are furnished on separate sheets, they shall be shown as a rectangle in the schematic diagram with all external points identified and cross-referenced to the separate sheets of the control circuit. Show coils and contacts internal to the subassemblies in the rectangle connected to their terminal points.

   b. For clarity, show control device symbols in the order in which the controls are positioned on the diagram.
c. Use a cross-referencing system in conjunction with each relay coil so that associated contacts may be readily located on the diagram. Where a relay contact appears on a sheet separate from the one on which the coil is shown, describe the purpose of the contact on the same sheet.

d. Show all spare contacts.

e. Show limit, pressure, level, flow, temperature, and similar switch symbols on the schematic diagram with all utilities turned off (electric power, air, gas, oil, water, lubrication, etc.) and with the equipment at its normal starting position.

f. Show contacts of multiple contact devices (e.g., selector switches and pushbuttons) on the line of the schematic diagram where they are connected in a circuit. Indicate a mechanical connection between the multiple contacts by a dotted line or arrow.

g. Additional charts or diagrams may be used to indicate the position of multiple contact devices such as limit, pressure, level, and selector switches.

h. Show the purpose or function of all switches adjacent to the symbols.

i. Show the purpose or function of controls such as relays, starters, contactors, solenoids, subassemblies, and timers on the diagram adjacent to their respective symbols. Show the number of positions of the solenoid valve adjacent to the valve solenoid symbol.

C. Operation and Maintenance Manual

Contractor shall submit a detailed Operation and Maintenance (O&M) Manual for all custom control panels specified herein and shown on the Drawings. The O&M Manual shall be provided in accordance with the requirements of the District's General Conditions, Specification Section 01430, and as specified herein.

The O&M Manual shall include, but not be limited to, the following:

1. Equipment Performance Data and Drawings

   a. Detailed Bill of Materials for all control panel equipment and components, listing: manufacturer's name, quantity, description, size, range, and model/part number.
b. Manufacturer's product literature, specifications, performance capabilities, features and accessories, and illustrations.

c. Manufacturer’s data and drawings showing dimensions, physical configurations, installation and mounting details, and wiring schematics.

d. Control ladder diagrams and wiring schematics. Loop diagrams for each monitoring and/or control loop.

2. Installation and Operation Requirements

a. Complete, detailed installation and operation instructions for all control panel equipment and components.

3. Service and Maintenance Data

a. Service and maintenance data shall include all information and instructions required by District’s personnel to keep the control panel and all associated components functioning properly under the full range of operating conditions.

b. Explanation with illustrations as necessary for each service and maintenance task.

c. Recommended schedule of service and maintenance tasks.

d. Troubleshooting instructions.

e. List of maintenance tools and equipment.

f. Recommended spare parts list.

g. Names, addresses and phone numbers of all manufacturers and manufacturer's local service representatives.

D. Final O&M Manual

Upon successful completion of startup and initial operation, Contractor shall submit a Final O&M Manual in accordance with the requirements of the District’s General Conditions, Specification Section 01430, and as specified herein. In addition to the O&M Manual requirements specified above, the Final O&M Manual shall be supplemented with the as-built drawings (including all field changes) for all control panel wiring and loop diagrams.
1.04 Design and General Requirements

A. Power for Control Panels and Interconnected Devices

1. All control panels shall be supplied with 480 VAC, 3-phase, 240 VAC Single Phase or 120 VAC Single Phase 60 Hz. power, as shown on the Drawings. All control panels shall be designed to minimize sources of control power (foreign power) from other panels.

2. Each control panel shall have a flange mounted disconnecting circuit breaker operable from the control panel front and interlocked with the enclosure door, to be used to isolate the control panel from the power supply.

3. The panel shall have a nameplate identifying the circuit breaker feeding the panel. Warning labels shall be provided identifying sources of foreign power to be disconnected prior to accessing the control panel.

4. The control voltage within the control panel controls shall be 120 VAC. Where the electrical power supply to the control panel is 240 VAC single phase or 480 VAC 3-phase, as shown on the Drawings, the control panel shall be provided with control power transformers, overcurrent protection, and power supplies to convert supply voltage to utilization voltage.

5. The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to solenoid valves, instruments, and transmitters both mounted in the control panel and remotely connected to the control panel.

B. Enclosure General Requirements

Unless indicated otherwise on the Drawings, or in the individual packaged equipment specification sections, control panels shall comply with the following requirements:

1. Control panels enclosures shall meet, or exceed, area classifications requirements per NEC.

2. Control panel enclosures shall have the following NEMA ratings:
   a. Enclosures installed indoors shall be rated NEMA 12.
   b. Enclosures installed outdoors shall be rated NEMA 4X.
   c. Enclosures installed indoors in wet or corrosive areas shall be rated NEMA 4X.
d. Enclosures installed indoors in hazardous areas shall be rated NEMA 7.

e. Enclosures installed outdoors in hazardous areas shall be rated NEMA 4 and NEMA 7.

3. Control panels shall be either freestanding, pedestal-mounted, wall-mounted, or equipment skid-mounted, as specified in the individual packaged equipment specification sections or indicated on the Drawings.

4. Internal control components shall be mounted on an internal back-panel.

5. Each source of foreign control voltage shall be isolated by providing fuses on a separate terminal block, clearly labeled for incoming foreign control voltage.

6. Discrete outputs from the control panel shall be provided by electrically isolated contacts rated for 5 A (minimum) at 120 VAC. Output isolation shall be provided through interposing relays or PLC relay output cards (if applicable).

7. Analog inputs and outputs shall be an isolated 4-20 mA 2-wire signal with power supply, power supply pilot light, and fuses.

8. Programmable Logic Controllers (PLCs) may be supplied in lieu of hardwired relay logic with the District's approval or if specified in the specification section for the specific equipment. The PLC shall be in accordance with Section 17010, Programmable Logic Controller.

9. All control panel mounted indicating lights, switches, and operator interface devices shall be mounted at least 3 feet above the finished floor elevation, but no more than 6 feet above the finished floor elevation.

10. Terminals shall be mounted vertical and locations of terminals and wireways shall be coordinated to account for conduit entrances.

11. Control panels that contain circuit breakers, combination full-voltage motor starters, soft starters, variable frequency drives, or other motor controls shall comply with the requirements Section 16480, Motor Control Centers, Switchboards, and Panelboards, and Section 16160, Variable Frequency Drives.
1.05 QUALITY ASSURANCE

A. References

This section contains references and information from the following documents which are made a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless specified otherwise, references to documents shall mean the documents in effect at the time of Bid (or on the effective date of the Agreement if there were no bids).

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>NFPA 70</td>
<td>National Electrical Code (NEC)</td>
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<tr>
<td>NFPA 70E</td>
<td>Standard for Electrical Safety in the Workplace</td>
</tr>
<tr>
<td>NFPA 79</td>
<td>Electrical Standard for Industrial Machinery</td>
</tr>
<tr>
<td>NEMA 250</td>
<td>Enclosures for Electrical Equipment (1000 Volts Maximum)</td>
</tr>
<tr>
<td>NEMA ICS 6</td>
<td>Industrial Control and Systems: Enclosures</td>
</tr>
<tr>
<td>UL 508A</td>
<td>Industrial Control Panels</td>
</tr>
<tr>
<td>UL 698A</td>
<td>Industrial Control Panels Relating to Hazardous (Classified) Locations</td>
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Assembly:

1. The assembled panels and individual components shall be Underwriters Laboratory (UL) listed and labeled.

2. Equipment and components shall be UL listed for the proposed purpose.

3. The control panels shall have factory applied UL 508A labels.

4. The intrinsic safety barriers required within a control panel shall be provided per UL 698A with factory applied labels as required by UL.

C. Factory Testing

Prior to shipment, the manufacturer shall test the functional operation of the control panels as specified in Part 3.01 herein.
D. **Environmental Sustainability**

1. All indoor and outdoor panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents.

2. Unless specified otherwise, heating, cooling and dehumidifying devices shall be provided in order to maintain all instrumentation components to within a range equal to 20 percent above the minimum and 20 percent below the maximum of the rated environmental operating ranges. All required power wiring and temperature controls shall be provided for these devices.

3. Enclosures suitable for the designated environment shall be furnished.

4. All control panels and instrumentation enclosures in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

### 1.06 DELIVERY, STORAGE, AND HANDLING

A. **Delivery**

All control panels shall be crated for shipment using heavy framework and skids:

1. Each panel shall further be cushioned satisfactorily to protect the finish of the instruments and panel during shipment.

2. All instruments, which are shipped with the panel, shall further have suitable shipping stops and cushioning material installed in a manner to protect instrument parts, which could be damaged due to mechanical shock during shipment.

3. Large panel units and/or panel units weighing over 100 lbs. shall be provided with removable lifting lugs to facilitate handling.

B. **Storage and Handling**

Control panels shall be stored and handled in accordance with the manufacturer's instructions and requirements and in a manner to protect the panel from the elements. Panels shall be handled in a manner to protect the components and enclosures.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Control panel enclosures shall be standard manufactured enclosures, whenever possible, and shall be as manufactured by Hoffman Engineering, Rittal, Stalin, or equal.

B. Dimensions

1. The Instrumentation and Control Subcontractor (ICS) and/or manufacturer of the packaged equipment system shall be responsible to design and size all panel enclosures based upon:
   a. Available space in area, as indicated on the Drawings.
   b. Equipment and device requirements for components located within the control panel enclosure.

2. The size of the control panel enclosures as indicated on the Drawings is based on preliminary, non-certified, information and as such these sizes are to be used as a general guideline.

3. A narrow or wide panel enclosure shall be provided if necessary to accommodate the available space. A larger enclosure shall be provided if necessary to accommodate the equipment, devices, and appurtenances located within the panel.

2.02 MANUFACTURED ENCLOSURES

A. Type NEMA 1 and NEMA 12 Enclosures for Indoor Installation

1. Unless specified otherwise, enclosures rated NEMA 12 shall be provided for all indoor panels located in dry, non-corrosive areas. Where panels are located in dry, non-corrosive areas and are required to be ventilated for cooling (fan or non-fan cooled), enclosures shall be rated NEMA 1 gasketed.

2. NEMA 1 gasketed enclosures shall be designed to house electrical controls, terminals, and instruments and shall provide protection from dust and dirt.

3. NEMA 12 enclosures shall be designed to house electrical controls, terminals, and instruments, and shall provide protection from dust, dirt, and oil.
4. Enclosure minimum construction requirements shall be as follows:
   a. Seams continuously welded and ground smooth.
   b. Door and body stiffeners as needed to make a rigid enclosure.
   c. Heavy gauge continuous hinge.
   d. Rolled lip around 3 sides of the door and all sides of the enclosure opening to prevent migration of liquids and contaminants into enclosure.
   e. Oil-resistant gasket attached to door with oil-resistant adhesive. Gasket to seal against roll lip on the enclosure opening.
   f. Interior back panel held in place by collar studs welded to enclosure. Back panel shall be full size, constructed of 10 gauge steel with stiffeners as required. Provide split back panel where specified or indicated on the Drawings.
   g. Door window where specified or indicated on the Drawings:
      i) Safety plate glass.
      ii) Held in place by rubber locking seal.
      iii) Sized to allow full view of alphanumeric display, operator interface, PLC Human-Machine Interface (HMI), etc.
   h. Door panel cutouts for instruments, devices, and windows shall be cut, punched, or drilled and smoothly finished with rounded edges. Reinforce around cutouts with steel angles or flat bars for large panel cutouts such as for HMIs and for pilot device groupings where the removed metal exceeds 50 percent of the available metal in an area bound by a 3-inch envelope around said pilot devices.
   i. Finish for NEMA 1 and NEMA 12 Enclosures
      i) All steel parts shall be provided with UL listed acrylic/alkyd baked enamel paint finish or TGIC powder coat, except plated parts used for ground connections. All painted parts shall undergo a multi-stage treatment process, followed by the finishing paint coat.
ii) Pre-treatment shall include:
   
a) Hot alkaline cleaner to remove grease and oil.

b) Iron phosphate treatment to improve adhesion and corrosion resistance

iii) The paint shall be applied using an electro-deposition process to ensure a uniform paint coat with high adhesion.

iv) The standard paint finish shall be tested to UL 50 per ASTM B117 (5% ASTM Salt Spray) with no greater than 0.125 inch loss of paint from a scribed line.

v) Paint color for enclosures shall be #49 medium light gray or #61 dark gray per ANSI Standard Z55.1 (60-70 gloss) on all exterior surfaces, unless specified otherwise. All unit interior surfaces shall be painted white for better visibility inside the unit.

vi) Panels that are in the same room as motor control centers switchboards, etc. shall be of the same color as the motor control center or switchboards so that the control panel blends into the lineup.

j. Manufacturer's standard gauge steel.

k. Each door to have a three-point latching mechanism and padlocking handle with rollers on the ends of the latch rods.

l. Print pocket inside door which shall be furnished with final as-built wiring diagrams and all applicable manufacturer warranties.

m. Heating and cooling per Part 1.05.D and Part 2.04 herein.

n. Heavy duty lifting eyes for all free standing panels.

o. Free standing, wall mount, or with floor stands or legs as indicated on the Drawings.

p. With flange mounted, disconnect for incoming power.

q. Hinges: steel piano-type running full length of doors.
r. Copper ground bus bar 1/4-inch x 1-inch with solderless connectors for all equipment grounds.

s. Bonding and grounding kit, including all cable and mounting hardware required to ground equipment to the door and body of the enclosure.

B. Type NEMA 4X Enclosures for Outdoor and Indoor (Wet or Corrosive Locations) Installation

1. Unless specified otherwise, enclosures rated NEMA 4X shall be provided for all outdoor panels and indoor panels located in wet, corrosive areas.

2. NEMA 4X enclosures shall be designed to house electrical controls, terminals, and instruments and shall provide protection from dust, dirt, oil, water, and corrosion.

3. In general, NEMA 4X enclosures shall be constructed of stainless steel. NEMA 4X enclosures constructed of non-metallic fiberglass reinforced polyester resin shall be provided only where specifically indicated on the Drawings or specified in individual specification sections for packaged equipment systems.

4. Minimum construction requirements for stainless steel enclosures shall be as follows:

   a. Type 316 stainless steel, 14-gauge minimum.

   b. Seams continuously welded and ground smooth.

   c. Door and body stiffeners as needed to make a rigid enclosure.

   d. Heavy gauge continuous hinge.

   e. Rolled lip around three sides of the door and all sides of the enclosure opening to prevent migration of liquids and contaminants into enclosure.

   f. Oil-resistant gasket attached to door with oil-resistant adhesive. Gasket to seal against roll lip on the enclosure opening.

   g. Interior back panel held in place by collar studs welded to enclosure. Back panel shall be full size, constructed of 10 gauge steel with stiffeners as required. Provide split back panel where specified or indicated on the Drawings.
h. Unless specified otherwise or indicated otherwise on the Drawings, panels shall be provided with interior swing-out door for:

i) Mounting switches, lights, devices, and HMI.

ii) A window shall be provided in the exterior door for view of interior lights, devices, and instruments if indicated on the Drawings.

i. Door panel cutouts (exterior and swing-out doors) for instruments, devices, and windows shall be cut, punched, or drilled and smoothly finished with rounded edges. Reinforce around cutouts with steel angles or flat bars for large panel cutouts such as for HMI and for pilot device groupings where the removed metal exceeds 50 percent of the available metal in an area bound by 3-inch envelope around said pilot devices.

j. Door window where specified or indicated on the Drawings:

i) Safety plate glass.

ii) Held in place by rubber locking seal.

iii) Sized to allow full view of alphanumeric display, operator interface, PLC Human-Machine Interface (HMI), etc.

k. Finish:

i) Stainless steel surfaces shall be unpainted and provided with a brushed finished.

ii) Interior steel parts shall be finished per Part 2.02.A.4.i herein. Finish paint color shall be white (60-70 gloss).

l. Each door to have a three-point latching mechanism and padlocking handle with rollers on the ends of the latch rods.

m. Print pocket inside door which shall be furnished with final as-built wiring diagrams and all applicable manufacturer warranties.

n. Heating and cooling per Part 1.05.D and Part 2.04 herein.

o. Heavy duty lifting eyes for all free standing panels.
p. Free standing, wall mount, or with floor stands or legs as indicated on the Drawings.

q. With flange mounted, disconnect for incoming power.

r. Hinges: steel piano-type running full length of doors.

s. Copper ground bus bar 1/4-inch x 1-inch with solderless connectors for all equipment grounds.

t. Bonding and grounding kit, including all cable and mounting hardware required to ground equipment to the door and body of the enclosure.

5. Minimum construction requirements for non-metallic enclosures shall be as follows:

a. Shall meet the applicable requirements herein for stainless steel enclosures plus the following additional requirements.

b. Non-metallic enclosures shall be molded fiberglass reinforced polyester resin with plate steel reinforcing on the sides, top, and bottom. The fiberglass reinforced polyester resin shall meet the following minimum standards:

i) Minimum flexural strength of 29,000 psi per ASTM D790.

ii) Maximum water absorption of 0.07% per ASTM D570.

iii) Minimum tensile strength of 17,500 psi per ASTM D651.

iv) Heat distortion at 400°F per ASTM D648.

v) Minimum specific gravity of 1.35 per ASTM D792.

vi) Minimum dielectric strength of 400 V/mil per ASTM D149.

vii) Minimum arc resistance of 180 seconds per ASTM D495.

viii) Flammability of 94V-O per ASTM D3801 and UL-94.

c. All seams shall be sealed.

d. Hinges shall be constructed of fiberglass with no exposed metal parts.
e. No exposed metal parts, except for captive stainless steel door screws which shall be replaceable.

f. Provisions for mounting panels shall be an integral part of the enclosure whether by way of internal mounting channels welded to the interior or by way of spot-welded collar studs.

g. Panel exterior gelcoat shall be UV light resistant and shall be light gray in color.

h. Each panel shall be provided with a stainless steel door hasp suitable for padlocking.

i. Enclosure mounting panels shall be constructed of 1/4” thick (minimum) aluminum plate with rounded corners and no sharp edges. Aluminum shall be provided with a uniform brushed finish.

2.03 ENCLOSURE LIGHTS AND RECEPTACLES

A. Each control panel shall be provided with LED lighting fixtures of sufficient size and quantity to provide 50 foot-candles of illumination within the panel. The lighting fixtures shall be horizontal LED tube type fixtures and shall be mounted to the top of the enclosure. The light fixtures shall be wired to a UL-approved switch mounted inside the panel.

B. Each control panel shall be provided with a duplex, 120VAC, 15A, 3-wire grounded GFCI type convenience receptacle.

C. The light fixture(s) and receptacle shall be provided with power by a control transformer in the panel or by a separate 120 VAC circuit, if indicated on the Drawings.

2.04 ENCLOSURE HEATING AND VENTILATION

A. Control panel enclosures shall be provided with heating and ventilation designed by the manufacturer to meet the following requirements and Part 1.05.D herein.

1. Space heaters shall be provided to prevent condensation. Space heaters shall operate on 120 V, 60 Hz power. Adjustable line voltage thermostats shall be provided for controlling the space heaters.
2. Non-forced air and forced air ventilation cooling shall be provided as required to maintain the required temperature of the housed equipment. Forced air ventilation shall be provided with supply fans mounted at the bottom of each enclosure section. The bottom door fans shall force fresh air into the enclosure to create a positive internal air pressure; and thereby, forcing out dirt and contaminants, and moving warm air out through ventilation louvers mounted at the top of the doors. A line voltage thermostat shall control the fans based on the panel internal temperature. Door interlock switches shall be provided to turn the fans off when the door is opened.

3. Supply fans shall be provided with air intake openings equipped with fixed louvers and washable aluminum mesh filters.

Ventilation air shall be exhausted through fixed, louvered openings equipped with washable aluminum mesh filters.

Air supply and exhaust openings shall be sized by the control panel manufacturer for the air flow required to maintain the proper inside temperature. All air filters shall be provided with interior door mounted frames allowing easy removal for cleaning.

B. Where necessary or where specified elsewhere, control panels shall be provided with air conditioning to maintain the required temperature for the housed equipment. Control panel air conditioning units shall be provided in accordance with the following requirements:

1. The air conditioning system shall provide closed-loop cooling and shall be sized by the control panel manufacturer based on: heat generated from all panel equipment and auxiliary components operating at full rated capacity, and said equipment operating under maximum ambient temperature conditions.

2. Unless specified otherwise, air conditioning unit shall operate on 115 V or 230 V, single phase, 60 hertz power supplied by the control panel.

3. Air conditioning unit shall be provided with: 16-gauge (minimum) welded steel framework, an efficient and quiet rotary compressor, built-in condensate evaporator, HFC environment friendly refrigerant, and additional corrosion protection for all aluminum, copper, and ferrous metal surfaces.

4. Air conditioning units for indoor control panels shall be furnished with built-in digital temperature controllers. Air conditioning units for outdoor control panels shall be furnished with remote temperature controllers mounted inside the control panel enclosure in an accessible and visible location.
5. Unless indicated otherwise on the Drawings, the air conditioning unit shall be designed to mount on the side of the control panel enclosure while maintaining NEMA Type 12, 4, or 4X integrity, and shall be furnished with a gasket kit at the interface between the enclosure and air conditioner. Air conditioning units mounted to NEMA Type 4X stainless steel enclosures shall be constructed of stainless steel.

6. Air conditioning unit shall be constructed to allow easy access for maintenance, including easy pull-out air filters. A minimum of three (3) spare replacement air filters shall be provided with each air conditioning unit.

7. Air conditioner units shall be UL listed, and shall be as manufactured by Ice Qube, Inc., or equal.

C. Control power transformers with primary and secondary fuse protection shall be provided as required for proper operation of the enclosure heating and ventilating equipment, unless Drawings show otherwise. Supply voltage shall be 120 VAC and 60 Hz. Separate line voltage thermostats shall be provided for heating and cooling.

2.05 CONTROL DEVICES AND COMPONENTS

A. Control Transformers

If incoming power supply as shown on the Drawings is other than 120 VAC, each control panel shall be provided with a control transformer. Control transformers shall comply with the following requirements:

1. Each control transformer shall be rated 480/120 V or 240V/120V single phase, 2 wire, 60 Hz, and shall conform to the applicable requirements of NEMA ST 1. The transformer shall have adequate volt-ampere capacity for all connected control function loads indicated, plus an additional 20 percent capacity. Transformer capacity shall be increased as required for any additional non-control function loads, such as condensation heaters, ventilation fans, or air conditioning.

2. Each control transformer shall be feed from the load side of the panel or motor controller disconnect. Control transformers rated 480/120 V shall be provided with two primary fuses rated to interrupt 50,000 A (minimum) at 600 V. One transformer secondary lead shall be provided with a time delay, slow-blow fuse rated to interrupt 10,000 A at 250 V, and the other secondary lead shall be grounded. All fuses shall be provided with blown fuse indicators.
Where control circuit power is provided from a source other than a unit transformer (e.g. a lighting panel circuit breaker), the motor controller disconnect shall include an electrical interlock for disconnection of externally powered control circuits.

B. Control Relays

Control relays shall be general purpose, electrically operated, magnetically held, plug-in blade or pin style with DIN rail mountable socket and LED indicator. Control relays shall be UL listed with 10 A rated contacts (thermal continuous current at 120 VAC), and shall be provided with 120 VAC coils, unless specified otherwise. Number of poles and pole arrangement shall be as indicated on the Drawings and as specified herein. Control relays shall be as manufactured by Allen-Bradley, IDEC, OMRON, Potter-Brumfield, or equal.

C. Time Delay Relays

Time delay relays shall be general purpose, multi-range, multi-function plug-in blade or pin style with DIN rail mountable socket and LES indicators (timing and timed out). Time delay relays shall be provided with multiple programmable timing ranges (0.5 sec to 24 hours, minimum) and multiple operating modes. As a minimum, relay operating modes shall include: on-delay, off-delay, repeat cycle off start, repeat cycle on start, and signal on/off delay. Time delay relays shall be UL listed with 5 A rated contacts (thermal continuous current at 120 VAC) non-inductive load, and shall be provided with 120 VAC coils, unless specified otherwise. Number of poles, pole arrangement, and maximum timing adjustment shall be as indicated on the Drawings and as specified herein. Time delay relays shall be as manufactured by Allen-Bradley, IDEC, OMRON, Potter-Brumfield, or equal.

D. Elapsed Time Meters

Elapsed time meters shall be electromechanical, NEMA Type 4X rated, with rectangular or round case suitable for flush panel mounting. Each meter shall have 6-digit (minimum) registers with counter numbers at least 3 mm high, and shall be non-resetable. White counter numbers on black backgrounds shall provide hour indication with the last digit in contrasting colors to indicate tenths of an hour. Each meter shall operate on 120 VAC input power. Elapsed time meters shall be as manufactured by Eaton, Honeywell/Hobbs, or equal.

E. Pilot Devices

1. Pilot devices consisting of pushbuttons, selector switches, pilot lights, and incidental items shall be as manufactured by Allen-Bradley, Eaton/Cutler Hammer, or Schneider/Square D (no substitutes).
2. Pilot devices shall be suitable for mounting on MCCs, switchgear, control panels, and control stations. Pilot devices shall be 30.5 mm, NEMA Type 4/13 with cast metal bases, chrome-plated octagonal mounting nuts, and legend plates.

3. Contact blocks shall have AC contact ratings of NEMA A600, 10 A with silver contacts for corrosion resistance and clear side plates for contact inspection.

4. Pushbuttons and switch knobs shall be heavy duty plastic. Unless indicated otherwise on the Drawings, switch knobs shall be black and pushbuttons shall colors shall be as follows:

<table>
<thead>
<tr>
<th>Color</th>
<th>Function</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Emergency Stop, Stop, Off</td>
<td>Emergency Stop button, Master Stop button, Stop of one or more motors</td>
</tr>
<tr>
<td>Yellow (Amber)</td>
<td>Return, Emergency Return, Intervention (suppress abnormal conditions)</td>
<td>Return of machine to safe position, override other functions previously selected</td>
</tr>
<tr>
<td>Green</td>
<td>Start-On</td>
<td>General or machine start. Start of cycle or partial sequence.</td>
</tr>
<tr>
<td>Black</td>
<td>No specific function assigned</td>
<td>Permitted to be used for any function except for those listed above.</td>
</tr>
</tbody>
</table>

5. Pilot light devices shall be push-to-test type and shall be provided with LEDs and transformers suitable for operation on 120 VAC power. Pilot light lenses shall be shatter resistant plastic. Unless indicated otherwise on the Drawings, pilot light lens colors shall be as follows:

<table>
<thead>
<tr>
<th>Color</th>
<th>Function</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Fail or Alarm (abnormal condition requiring immediate attention)</td>
<td>Indication that a protective device has stopped the machine, e.g. overload</td>
</tr>
<tr>
<td>Yellow (Amber)</td>
<td>Warning (marginal condition, change or impending change of conditions)</td>
<td>Some value (e.g. pressure) is approaching its permissible limits. Overload permitted for a limited time. Ground fault indication.</td>
</tr>
<tr>
<td>Color</td>
<td>Function</td>
<td>Examples</td>
</tr>
<tr>
<td>--------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>White</td>
<td>Normal Condition, Confirmation</td>
<td>Normal pressure. Control power on.</td>
</tr>
</tbody>
</table>

F. Mounting of Instruments

1. Provide cutouts, and door mount all instrument items indicated on the Drawings or specified to be panel mounted, including any instruments specified to be furnished by other vendors but installed in panel (if applicable).

2. Mount, behind panel doors, other instrument accessory items as required and/or specified.

3. The rear of panel mounted equipment shall be installed with due regard to commissioning adjustments, servicing requirements and cover removal.

4. Spare space shall be kept clear of wiring, etc. to give maximum space for future additions.

G. Door Mounted Device Shield

Provide a clear acrylic glass (Plexiglass) shield to cover back of door mounted devices (lights, switches, OIT, etc.). Plexiglass shield shall be 1/8" thick and shall be mounted to the panel door (outer door and/or inner swing-out door) with 1/4" diameter stainless steel bolts and spacers between back of panel door and Plexiglass shield. Bolts and spacers shall be provided at shield corners and along shield edges as necessary to provide a rigid shield.

H. Terminals and Power Supplies

All terminals and power supplies shall be as manufactured by Phoenix Contact (no substitutes).

1. Provide terminal blocks for all incoming and outgoing control wires. Unless indicated otherwise on the Drawings, mount terminal blocks vertically. Wire and mount terminal blocks so that internal and external wiring do not cross over the terminals. No more than two conductors shall be terminated at each terminal connection.
2. Field wiring shall terminate on the "field side" of the terminal blocks. Do not connect internal panel wiring to the "field side" of the terminal blocks. Do not connect field wiring to the "panel side" of the terminal block.

3. Unless specified otherwise, all field wiring shall be connected to fused terminal blocks, including input and output terminals to and from PLCs. PLC loop powered analog signals shall be connected to two-level, non-fused terminal blocks.

4. Terminal blocks shall be modular, rail mounted, rated at 20 amperes, 600 volts capable of terminating wire sizes 12 through 24 AWG and constructed of polyamide thermoplastic. Terminal blocks shall be UL listed in accordance with UL 486A and 1059. All current carrying parts shall be made of copper or brass electroplated with tin/lead. Terminal connection shall be a screw clamp pressure plate connection, designed such that the clamping screw does not clamp the screw directly to the wire.

5. Provide symmetrical steel assembly rails, end brackets, jumper bars, and other accessories as required for a complete terminal block assembly.

6. Terminal blocks shall be consecutively numbered from top to bottom with preprinted marking tags. Tags shall be white polyamide and hot printed with black symbols so that the print is permanent.

7. Specific model terminal blocks shall be as follows:
   a. Phoenix Contact Terminal Block, Single-Level, Non-Fused, Model UK5N
   b. Phoenix Contact Terminal Block, Two-Level, Non-Fused, Model UKKB5
   c. Phoenix Contact Terminal Block, Fused, Model UKK5-HESILED
   d. Phoenix Contact End Cover, Model D-UKKB3/5
   e. Phoenix Contact Clamp, Model E/UK1.

   Alternate model terminal blocks or terminal blocks from other manufacturers are not acceptable.

I. Power Supplies

Unless specified otherwise, power supply shall be Phoenix Contact Power Supply AC-DC 24V @ 2A 85-264V In, Enclosed DIN Rail Mount Mini Series, Model 2938730. Alternate model power supplies from other manufacturers are not acceptable.
2.06 MARKERS AND NAMEPLATES

A. Markers

Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number, which shall be shown on all manufacturer shop drawings. These numbers shall be marked on all conductors at every terminal. Conductor markers shall be pre-printed white identification tags with clear heat shrinkable tubing. Heat shrinking of the identification tags and clear tubing shall be in accordance with manufacturer's specifications.

1. Conductor identification tags shall be in accordance with the following requirements:

a. The conductor identification tags shall consist of heat shrinkable flame retarded identification sleeves that fit tightly over the conductor or cable to be marked. Identification sleeves shall be made of a seamless cross-linked polyolefin with a 3 to 1 shrink ratio.

b. The conductor identification tag system shall be UL recognized to Standard 224, MIL-M-81531. Identification tags shall be smear resistant prior to shrinking and achieve a permanent mark when shrunk, without the need for permatizing equipment. Identification marks shall be legible after 20 eraser rubs and 30 solvent brush strokes.

c. Identification sleeves shall be seamless. Sleeves shall be resistant to common industrial fluids including Freon TF, Isopropyl Alcohol and Ethylene Glycol. Identification sleeves shall have a temperature range of -30°C to 105°C and a dielectric strength of 500 V/mil minute. The identification sleeves shall be suitable for indoor or outdoor use. The conductor identification tag system shall be as manufactured by Raychem/Kroy Cable Marking, or Brady-Permasleeve White Polyolefin (B-342), or equal. Heat shrinkable thermoplastic tags are not acceptable.

2. The conductor identification sleeves shall be provided with heat shrink clear tubing in accordance with the following:

a. To provide a long-term permanent marker in high ambient temperatures, a translucent (clear) shrink tube shall be placed over each wire marker (extending past both edges of adhesive wire marker) and heat shrunk.
b. The clear tube shall be suitable for high temperature performance, abrasion resistance and cut-through resistance and resistant to chemicals and solvents. The clear tubing shall meet the high temperature performance that meets or exceeds military industrial standards: MIL-1-23053, Test C, with UL VW-1 ratings. Operating temperature range shall be -55°C to 175°C. Product shall be Kynar as manufactured by Raychem, or equal.

B. Nameplates

1. Plainly and permanently identify control and power devices using the same identification as shown on the schematic diagrams. Show identification for devices inside the enclosure on a nameplate adjacent to, not on, the device.

   a. Exception No. 1: Where the size or location of the devices make individual identification impractical, such as on electronic assemblies, use group identification.

   b. Exception No. 2: Where panel layouts do not permit the mounting of identification nameplates adjacent to components, such as relays, place the permanent relay identification on the relay where it is plainly visible, and provide a second identification on the top of the panel wireway cover directly below the relay. Identify the wireway covers to show their proper location.

2. Identification nameplates for devices mounted inside and outside the control enclosure shall be one of the following:

   a. Laminated phenolic for engraving stock; a minimum of 0.062 inch thick with black background and white lettering. Fasten nameplates with stainless steel drive screws, or the equivalent. Use permanent adhesives for attaching nameplates to wireway covers.

   b. Stainless steel; a minimum of 0.031 inch thick for engraving stock or 0.012 inch thick for embossing stock. Fasten nameplates with stainless steel drive screws, or the equivalent.
2.07 WIRING METHODS

A. Panel wiring shall be neatly contained in panel wireways, including incoming and outgoing field control wiring. Provide separate wireways for internal wiring and field wiring. Panelways shall be colored white for 240 VAC circuits and colored light gray for 120 VAC, restricted slot design, with matching snap on overs. Provide panelways with mounting holes and nylon "push" rivets for mounting. Panelways material shall be PVC or noryl. Panelways shall be as manufactured by Panduit, or equal.

B. Provide minimum 2 inches of clearance between panelway and wire terminations to allow for clear viewing of wire identification marking.

C. Wiring run to control devices on the front door shall be tied together at short intervals and secured to the inside front door with Panduit adhesive mounts. Mounts shall be Clincher adjustable releasable clamp type for wire bundles 0.69 inch in diameter or smaller, or AM2-C mounts with Uni-Ty releasable nylon cable ties for bundles larger than 0.69 inch in diameter. Mounts shall be attached to front panel with Eastman 910 adhesive, or equal.

D. Signal and Control Circuit Wiring

1. Wire type and sizing:
   a. Conductor shall be flexible stranded copper machine tool wire.
   b. These shall be UL listed Type MTW flexible or Type SIS and shall be rated 600 volts.
   c. Wires for instrument signal circuits and alarm input circuits shall be No. 14 AWG, minimum.
   d. Wires connecting to PLC wiring arms shall be multiconductor No. 16 AWG, minimum.
   e. All other wires, including shielded cables, shall be No. 16 AWG, minimum. Shielded cables shall be used for analog signals.
   f. Wire insulation colors shall be as follows:
      i) Control Wiring
         a) PLC Inputs (Status) DI = Blue
         b) PLC Outputs DO = Brown
         c) 12VDC Positive = Red
d) 12VDC Negative = Black  
e) 24VDC Positive = Yellow  
f) 24VDC Negative = Blue  
g) 120 VAC Positive = Red  
h) 120 VAC Negative = White  
i) 120VAC Switch Leg = Do not use Black, Red or Blue  
j) 480 VAC Switch Leg = Do not use Brown, Orange or Yellow  

ii) Power Wiring  
 a) 480 VAC A-Phase = Brown, B-Phase = Orange,  
    C-Phase = Yellow  
b) 120/208/240 VAC A-Phase = Black, B-Phase = Red, C-Phase = Blue  
c) Phase tape with colors is acceptable  
d) Foreign Power = Yellow  

Note: Match existing wiring when appropriate.

2.08 SPARE PARTS

A. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished. Spare parts shall be properly packaged for shipment and storage, and shall be labeled with the manufacturer's part number(s).

B. As a minimum, Contractor shall furnish the following spare parts:

1. Five (5) fuses of each type and size for single-phase power (including control power).

2. Two (2) indicating light assemblies for each type of pilot light.

3. One (1) control relay of each type and rating.

4. One (1) time delay relay of each type and rating.

C. Where control panels operate on 3 phase power and/or are equipped with motor starting equipment and components, Contractor shall furnish the following additional spare parts:

1. Three (3) fuses of each type and size for three-phase power.
2. Two (2) complete sets of 3-pole stationary and moving contact assemblies for each size AC contactor.

3. Two (2) operating coils for each size AC contactor.

4. One (1) contactor auxiliary contact of each type.

5. Three (3) contactor overload relays of each type and rating, each relay with a complete set of contact blocks.

6. One (1) spare set of heater elements for each heater rating provided.

**PART 3 - EXECUTION**

### 3.01 FACTORY TESTS

Prior to shipment, each control panel shall be inspected and tested for correct operation by the manufacturer. Each circuit shall be tested for continuity, short circuits, and fault grounds. The functional operation of the control panel shall be tested, including operation of all input and output (I/O) points, control devices, and motor controls. Temporary connections shall be provided between control panels and other system components. Subsequent testing of the system shall include, but not be limited to, programming of the PLC and operator interfaces. PLC system shall be programmed as required.

#### A. Initial Testing

Initial testing of the control panel shall include configuration of the PLC and its communications equipment (where PLC is provided) energizing each digital I/O and simulating each analog I/O using a loop simulator and calibrator. Circuits not energized shall be tested for continuity. Energized circuits shall be tested through all components from the terminal blocks in the control panel to the control devices and hardware I/O memory locations in the PLC. Testing of the control system shall be considered completed after control system operation has been successfully simulated at least four (4) times.

An I/O checklist shall be provided for all points in the control panel. The checklist shall include, for each point, the tag name of the point, a description of the point, comments, date and time of the test, and a signature line for the person performing the test. Where a PLC is provided, each digital point set and reset shall be shown. Verification of all analog points shall be shown at 0%, 25%, 50%, and 100% of range. The checklist shall be submitted to District.
B. **District-Witnessed Factory Testing**

District shall have the option of witnessing the functional shop test. Contractor shall notify District at least three (3) weeks prior to the scheduled functional shop test.

After completion of initial testing, the subsequent testing shall be conducted for inspection by District. All control functions and all status and alarm monitoring and indication shall be demonstrated under simulated operating conditions. Simulating equipment shall be provided and wired into the control system for this testing. The system shall be revised, modified, and adjusted as required by District during the testing period. Testing shall continue for the time period required by District to observe and verify any revisions and shall continue to District’s satisfaction. Where panel is equipped with a PLC, the PLC and HMI programs shall be loaded and fully tested in the factory. All hardware, instruments, and software shall be provided as necessary to perform the testing.

3.02 **SITE TESTS**

A. **General**

Control panel shall be tested with all field wiring connected. All adjustable set points and time delays shall be set as required. Operation of control panel and field devices shall be checked to verify correct operation. All required adjustments shall be made as required for correct operation.

B. **Specific Field Verifications**

The following specific field verifications shall be performed:

1. Panel control circuits are grounded with one (1) terminal of each load device connected to the grounded conductor.

2. Panel signal and control wiring are separated and installed in separate wireways with barriers between the power wiring and the signal and control wiring.

3. Panel is connected to the facility grounding system as specified.

4. Panel tops of wall-mounted panels are mounted at the same elevation (unless noted otherwise).

5. Panel inner door contains a copy of the as-built elementary and wiring diagrams.

6. Panel inner door contains copies of all applicable equipment warranties.
7. Panel inner door contains a drawing holder.

8. Panel as-built shop drawings and applicable equipment warranties are enclosed in a transparent, protective jacket.

9. All panel functions are as specified.

3.03 CONTROL PANEL MOUNTING

A. General

Control panels shall be field mounted as indicated on the Drawings or on equipment supplied as shown on District-accepted shop drawings.

B. Mounting Requirements

Unless indicated otherwise on the Drawings or in the specification sections for the packaged equipment systems, control panels shall be mounted as follows:

1. Control panels supported directly by concrete or concrete masonry walls shall be spaced apart not less than 1-5/8" by strut channel between panel and wall. Strut channel shall be attached to the wall as shown on the Drawings. Panels shall be attached to strut channel with stainless steel strut threaded studs, washers, and nuts. Unless specified others, strut stud diameter shall be 1/16" less than the panel mounting holes.

2. Panels shall be mounted to structures or support systems that are free of vibration or shock.

3. Support systems shall not be attached to handrails, process piping, or mechanical equipment, unless indicated on the Drawings.

4. Unless indicated otherwise on the Drawings, materials used for support of control panels shall be constructed of Type 316 stainless steel. Support systems, including panels, shall be designed to prevent deformation greater than 1/8" under the enclosed equipment load and an external load of 200 pounds in any direction.

5. Panels shall be shimmed to precise alignment so doors operate without binding.

6. Floor-mounted cabinets shall be mounted on 3" minimum high concrete housekeeping pads or grouted bases as indicated on the Drawings.
7. Terminals and terminal blocks shall be sprayed with a silicone resin, similar to Dow Corning R-4-3117 conformal coating, after all terminations and testing have been completed.

3.04 MANUFACTURER'S SERVICES

Unless specified otherwise, equipment manufacturer’s services shall be provided at the job site for the minimum number of 8-hour work days listed below, travel time excluded:

A. Two (2) work days to check the installation, calibrate the equipment, supervise start-up, and supervise testing of the system.

B. One (1) work day to instruct the District's personnel in the operation and maintenance of the equipment.

END OF SECTION
SECTION 17006
GENERAL INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Contractor shall provide all equipment, materials, and labor, and required to place into service a fully configured, integrated, and operational instrumentation and control system as indicated on the Drawings and specified herein.

B. Design, fabricate, coordinate, install, calibrate, and test the instrumentation and control system to provide proper operation and to interface with related equipment and materials.

C. Furnish and install auxiliary and accessory devices necessary for system operation or performance and to interface with equipment specified herein and in other Sections of these Specifications.

1.02 RELATED SECTIONS

A. The Contract Documents are a single integrated document, and as such all Specification Sections apply. It is the responsibility of the Contractor and its subcontractors to review all Sections and ensure a complete and coordinated project.

B. Related Specification Sections include, but are not limited to, the following:

1. Division 11 – Equipment
2. Division 13 – Special Construction
3. Division 15 – Mechanical
4. Division 16 – Electrical
5. Division 17 – Instrumentation and Controls
1.03  REFERENCE STANDARDS AND CODES

A.  International Society of Automation (ISA)
   1. ISA S5.1 – Instrumentation Symbols and Identification.
   2. ISA S5.3 – Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
   3. ISA S5.4 – Instrument Loop Diagrams.
   4. ISA S20 – Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.

B. National Electrical Manufacturers Association (NEMA)

C. National Fire Protection Agency (NFPA)
   1. NFPA 70 - National Electrical Code (NEC).
   2. NFPA 79 – Industrial Control Equipment.

Equipment and materials, including installation of same, shall meet or exceed the applicable requirements of the above standards and codes (latest edition).

1.04  INSTRUMENTATION AND CONTROL SUBCONTRACTOR

Contractor shall designate an Instrumentation and Control Subcontractor (ICS) to be responsible to furnish all services, equipment, and material specified herein.

A. Qualifications
   1. As a minimum, the ICS shall have been regularly engaged in the design, selection, purchase, fabrication, installation, calibration, startup, and testing of instrumentation and control equipment on municipal water and wastewater projects.
   2. ICS shall have been regularly engaged in performing coordination, design, and selection of equipment and controls to interface between
instrumentation and control equipment, and to interface with system control panels, motor control centers, variable frequency drives, packaged systems, programmable logic controllers, etc. for municipal water and wastewater projects of similar or larger magnitude for at least 5 years.

3. Contractor shall submit ICS qualifications and project references (5 minimum) for District review and approval.

4. Personnel employed for system engineering, coordination, supervision, installation, startup, operational testing, and training shall be regularly employed and trained by the ICS.

B. Responsibilities

1. Design, select, fabricate, coordinate, calibrate, and test the instrumentation and control system to provide proper operation and to interface with related equipment and materials furnished by other suppliers under other Sections of these Specifications, with existing facilities (where required), and with District provided Remote Telemetry Unit (RTU) equipment and/or Supervisory Control and Data Acquisition (SCADA) system equipment.

2. Coordinate the design, selection, and fabrication of instrumentation and control systems furnished by others, and confirm that the proposed equipment will provide the required monitoring/control and shall properly interface with other equipment systems (new and existing).

3. Design and prepare control and interconnect diagrams (loop drawings) for all field devices, local control panels, main control panels, motor control centers, etc. showing wiring interconnections for all project equipment, instrumentation, and controls (including existing equipment, instrumentation, and controls).

4. Review and approve shop drawings prepared by the motor control center, variable frequency drive, and other electrical equipment suppliers. ICS shall date and sign said shop drawings prior to submittal to the District for review.

5. Coordinate work so that all components of the instrumentation system, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, alarming devices, and all appurtenances
are selected, designed, and calibrated to provide the specified accuracy and performance, and are completely compatible and shall function as specified.

6. Provide auxiliary and accessory devices necessary for system operation or performance and to interface with equipment provided by other suppliers under other Sections of these Specifications, with existing facilities (where required), and District provided RTU equipment and/or SCADA system equipment. These devices include, but are not limited to, current isolators, signal conditioners, transducers, and interposing relays. These devices shall be provided whether they are shown on the Drawings or not, and shall be at no additional cost to the District.

7. Installation of instrumentation and control equipment and materials need not be performed by the ICS; however, the ICS shall provide onsite technical supervision of the installation.

8. Prior to installation of any conduit associated with instrumentation and controls, the ICS shall verify conduit size and conduit runs with the Electrical Subcontractor and equipment suppliers for specific equipment to be furnished, and notify the District of any conflicts or deviations.

9. Coordinate services of manufacturer’s engineering representatives for instrumentation and control equipment during installation, startup, operation, and instruction of District personnel.

Contactor shall subcontract the work specified herein to a qualified ICS. All work performed is the responsibility of the Contractor even though references are made herein to work requirements and responsibilities of the ICS and Electrical Subcontractor.

1.05 PERFORMANCE SPECIFICATIONS AND DRAWINGS

Instrumentation and control systems shall be furnished and installed to provide equipment performance, operation control, and/or monitoring functions as specified on the Drawings, in specific equipment sections of these Specifications, or in the Special Conditions. Control schematic diagrams, where provided on the Drawings, show control wiring and control functions for specific equipment. ICS shall prepare, or coordinate preparation of all wiring and control diagrams, and computer programs. ICS shall furnish and install all instrumentation and control components required to provide said specified performance and operation.
1.06 INSTRUMENTATION AND CONTROL EQUIPMENT

Instrumentation and control equipment shall be as specified herein, per individual equipment sections of these Specifications, and as shown on the Drawings. Not all products specified herein are necessarily required for this project.

1.07 SUBMITTALS

All submittals shall be in accordance with the General Conditions, Section F - Labor and Construction, and requirements specified herein.

A. Shop Drawings

Contractor shall prepare and submit complete and organized information, drawings, and technical data for all equipment and components. All drawings shall be legible and reduced to a maximum size of 11” x 17” for inclusion within the submittal. Shop drawings shall include, but not be limited to, the following:

1. Detailed Bill of Materials for all instrumentation and control equipment, and appurtenances, listing: manufacturer's name, quantity, description, size, range, and catalog/part number.

2. Summary data sheets for all instrumentation and control equipment in accordance with ISA-20.00.01 format. As a minimum, data sheets shall include the following information: Plant equipment name/number and ISA tag number shown on the Drawings (where provided); item name as specified herein, or separate Specification sections, or indicated on the Drawings; manufacturer’s complete model number, item location; input/output characteristics; range, size, and gradation in engineering units; materials of construction for wetted parts and enclosure; and enclosure NEMA classification.

3. Complete documentation for all instrumentation and control equipment, including: manufacturer's product literature, specifications, performance capabilities, features and accessories, materials of construction, illustrations, and data in sufficient detail to demonstrate compliance with Specification requirements. Manufacturer’s literature and data shall be marked to clearly delineate all applicable information and crossing out all inapplicable information.

4. Engineering selection and design parameters and calculations for instrumentation and control components including range, material
compatibility for process medium, temperature ratings for project ambient conditions, temperature error and proposed mitigation for same, and other pertinent selection and sizing criteria.

5. Manufacturer’s data and drawings showing dimensions, physical configurations, methods of connecting instruments and control equipment together, installation and mounting details, single instrument loop diagrams, and wiring schematics.

6. Product data sheets for instrument cables and controller/transmitter cables. Installation requirements for cables and conductors, including shielding, splicing, and grounding requirements.

7. Control program for programmable controllers (if applicable) with complete listing and description of all program functions, all input and output parameters, and factory settings.

8. Interface between instruments, controllers, motor starters, control panels, variable frequency drives, PLCs, etc., District furnished equipment (when supplied), and other equipment related to the instrumentation and control system.

9. Control ladder diagrams for all control, protection and monitoring circuits, including control panel wiring. Ladder diagrams shall show all switches, push buttons, relays, timers, etc. Show all interconnections between power sources and device elements of a particular system or equipment, and all interlocks with other equipment/systems in a manner that fully indicates the circuit function and operation.

10. Loop diagrams for each monitoring and/or control loop. The loop diagrams shall show all components of the loop: analog, digital, and discrete, including all relays, switches, signal isolators, etc., which are being provided for proper operation. Loop diagrams shall be provided for all analog and control system components, including those components specified in other Sections of these Specifications and/or shown on the Drawings. Loop diagrams shall be prepared according to ISA-S5.4 format, and shall also include the following:

   a. All interconnecting wiring between equipment, panels, terminal junction boxes, and field mounted components. Show all panel terminal board identification numbers and all wire numbers.
Show all intermediate terminations between field elements and panels.

b. The location of all devices.

c. The instrument description, including type, manufacturer, model number, range, set points, and operation (e.g. fail open, open on energization, normally closed, etc.) as applicable.

d. The instrument loop power requirements back to the termination on the terminal block, fuse block (including fuse size), etc., as applicable.

e. All grounding points within cabinets and panels and identify the connection point of individual components.

f. Each diagram shall include a table summary with output capability of the transmitting instrument, input impedance of each receiving instrument, estimate of loop wiring impedance based on wire size and approximate length, total loop impedance, and reserve output capacity.

11. Interconnection diagrams for all field devices, local control panels, main control panels, motor control centers, etc. showing wiring interconnections for all project equipment, instrumentation, and controls (including existing equipment, instrumentation, and controls). Interconnection diagrams shall be provided for all equipment and appurtenances, including equipment specified in other Sections of these Specifications and/or shown on the Drawings. Interconnection diagrams shall be point-to-point type and shall show all conduit and wiring interconnections with electric panel and circuit numbers for all power sources.

12. Proposed nameplate descriptions for all instrumentation and control equipment.

B. Field Testing and Demonstration Plan

Contractor shall prepare and submit for approval a written plan for field testing and demonstrating that each instrumentation and control system meets the specified operational and performance requirements. Submit a written plan
with step by step procedures to be used during pre-startup, startup, and final demonstration testing of system operation and performance.

C. **Operation and Maintenance Manual**

Contractor shall submit a detailed Operation and Maintenance (O&M) Manual for all instrumentation and control equipment specified herein and incorporated into the Work. The O&M Manual shall be provided in accordance with the requirements of the District's General Conditions, Section 01430, and as specified herein.

The O&M Manual shall include, but not be limited to, the following:

1. **Equipment Performance Data and Drawings**
   a. Detailed Bill of Materials for all instrumentation and control equipment, and appurtenances, listing: manufacturer's name, quantity, description, size, range, and model/part number.

   b. Manufacturer's product literature, specifications, performance capabilities, features and accessories, materials of construction, and illustrations.

   c. Manufacturer's data and drawings showing dimensions, physical configurations, installation and mounting details, single instrument loop diagrams, and wiring schematics.

   d. Control diagrams, loop diagrams, and interconnect diagrams for all field devices, local control panels, main control panels, motor control centers, etc. for all project equipment, instrumentation, and controls (including existing equipment, instrumentation, and controls).

2. **Equipment Installation Requirements**
   a. Complete, detailed installation instructions for all instrumentation and control equipment, and appurtenances.
3. Equipment Operation Data
   a. Complete and detailed instructions for adjusting all equipment settings, including: input power, output signal, range, span, sensitivity, etc.
   b. Complete and detailed user manuals and operating instructions, including operator interface menus, programming, and setup parameters for all controllers.
   c. Printed list of all final setup parameters for each controller, including factory settings and any field modifications to factory settings.

4. Equipment Service and Maintenance Data
   a. Maintenance data shall include all information and instructions required by District's personnel to keep equipment adjusted and calibrated so that it functions properly under the full range of operating conditions.
   b. Explanation with illustrations as necessary for each maintenance task.
   c. Recommended schedule of maintenance tasks.
   d. Troubleshooting instructions.
   e. List of maintenance tools and equipment.
   f. Recommended spare parts list.
   g. Names, addresses and phone numbers of all manufacturers and manufacturer's local service representatives.

5. Manufacturer Warranties

D. Final O&M Manual

Upon successful completion of startup and initial operation, Contractor shall submit a Final O&M Manual in accordance with the requirements of the
District’s General Conditions, Specification Section 01430, and as specified herein.

1. As-built drawings (including all field changes) for all wiring and interconnection diagrams shall be incorporated into the Final O&M Manuals.

2. In addition, pre-startup and post-startup written certification reports as specified herein shall be included in the Final O&M Manual.

1.08 QUALITY ASSURANCE

A. Manufacturers

To facilitate the District’s future operation and maintenance, furnish equipment which is the product of one manufacturer to the maximum extent possible. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.

All equipment shall be of the manufacturer’s latest design and shall produce or be activated by signals which are standards for the water and wastewater industry.

B. Model Numbers

Model numbers supplied herein are provided for information purposes only, to assist Contractor in selecting equipment that conforms to the Specification and Drawing requirements. In case of any conflict between model numbers provided and the descriptive requirements specified herein, the descriptive requirements shall govern.

C. Standard of Quality

Only equipment of the types and sizes specified which has been demonstrated to operate successfully shall be furnished. All material and equipment furnished shall be listed by and shall bear the label of Underwriters Laboratories (UL), Edison Testing Labs (ETL), or Factory Mutual (FM).

D. Instrumentation and Control Subcontractor’s Certifications

Prior to startup and initial operation of all instrumentation and control equipment (including existing instrumentation and control equipment), the ICS
shall submit a written report stating that equipment has been coordinated, calibrated, properly installed, and is ready for startup. After startup and when equipment is ready to be operated, the ICS shall submit a written report for the instrumentation and control equipment certifying that the equipment is ready to be operated, is safe to operate and has been checked, inspected, calibrated, and adjusted as necessary; has been operated under varying service conditions and operated satisfactorily; and is fully covered under the terms of the guarantee.

PART 2 - PRODUCTS

2.01 GENERAL

A. Where indicated on the Drawings, specified by the individual equipment sections in these Specifications, or by the Special Conditions, the instrumentation and control components shall be as specified herein.

B. Unless specified otherwise, all equipment shall be suitable for operation over an ambient temperature range of 15°F to 122°F, and at a maximum elevation of 3,300'. Cooling or heating equipment shall be provided if required by the instrumentation and control equipment. Where dissipation of heat cannot be adequately accomplished with natural convection (NEMA 4X enclosures) or forced air ventilation (NEMA 1 gasketed enclosures), additional cooling or heating shall be furnished.

C. Unless specified otherwise, electrical enclosures for indoor equipment shall be rated NEMA 1 gasketed, or better. Unless specified otherwise, electrical enclosures for outdoor equipment shall be rated NEMA 4X. Outdoor enclosures with sunlight exposure shall be provided with sun shields. In addition, instrumentation located in areas subject to wash down or exposure to chemicals shall be provided with NEMA 4X electrical enclosures.

D. All instrumentation in hazardous areas shall be intrinsically safe and shall be approved for use in the particular hazardous (classified) location in which it is to be installed.

E. All panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be of one manufacturer.

F. Analog measurements and control signals shall be as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted.
Unless specified otherwise, analog output signals shall be 4 to 20 milliamperes (ma) DC.

G. Unless specified otherwise, power for the instrument and control equipment shall be 120VAC, single phase, 60 Hz.

H. Where DC power supplies are not furnished integral with any one instrument system loop, Contractor shall provide a separate solid-state power supply and fuses (primary and secondary).

2.02 GENERAL REQUIREMENTS FOR COMPONENTS AND APPURTENANCES

A. Materials and Components

Electrical materials and components shall be as specified in Section 16050, as indicated on the Drawings, and as specified herein.

B. Signal Isolators, Converters, and Power Supplies

Signal isolators shall be furnished and installed in each measurement and control loop, wherever required to ensure adjacent component impedance match, or where feedback paths may be generated. Signal converters shall be included where required to resolve any signal level incompatibilities. Signal power supplies shall be included, as required by the manufacturer’s instrument load characteristics, to ensure sufficient power to each loop component.

C. Tags and Nameplates

1. Each field instrument shall be provided with a rectangular Type 316 stainless steel tag. The tag shall be engraved with the project instrument tag number. The instrument tag shall be attached directly to the instrument with stainless steel screws or with a stainless steel chain.

2. Each panel mounted instrument, controller, or control component shall be provided with a nameplate. The nameplate shall be engraved with the project description of the device. Nameplates shall conform to the requirements of Section 16050.
D. **Wiring and Cables**

1. **Wire Type and Sizes**

   All power and control wiring shall be provided in accordance with Section 16050. Instrument supply power conductors shall be minimum #12 AWG. Control signal conductors shall be minimum #14 AWG. Wire insulation colors shall be in accordance with Section 16050.

2. **Cables**

   Shielded cables shall be minimum #16 AWG and shall be in accordance with Section 16050. Instrument transducers or sensors requiring special cable shall be provided by the instrument manufacturer and shall be factory connected to the device. Cable between the transducer or sensor and corresponding controller shall be provided with the device. ICS shall verify the length of cable required for each specific installation location. Cable shall be installed in a single run with no splices.

3. **Wire Termination**

   Conductors from field instruments or components shall terminate in control panels, MCC sections, etc. at terminal blocks.

4. **Wire Marking**

   All conductors and cables shall be marked at termination points with a marking system as specified in Section 16050.

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### 2.03 FLOAT SWITCHES AND INTRINSICALLY SAFE RELAYS

A. **Float switches** shall be designed for operation in water and raw sewage and shall be hermetically sealed in high impact corrosion resistant polypropylene or polyurethane. Cable shall be minimum 16 gauge multi-strand polyvinylchloride (PVC) jacketed cable (oil and water resistant) suitable for underwater use and heavy flexing service. Float switches shall be rated minimum 4 A at 120 VAC. Each float switch shall be utilized for one operation. A single float switch shall not be used as example for pump start and stop.

B. **Float switches** shall be as manufactured by Flygt Corporation, Warrick Controls, Anchor Scientific Inc., Consolidated Electric Co., or equal.
C. Unless specified otherwise, each float switch shall be provided with an intrinsically safe relay complete with reduced voltage transformer and contacts. Intrinsically safe relays shall be specified for use in NEC, Class I, Division 1 (hazardous) locations, and shall be Factory Mutual or UL listed for explosion proof service. Intrinsically safe relays shall be as manufactured by Warrick (no substitutes).

2.04 PRESSURE GAUGES

A. Unless otherwise shown or specified, pressure gauges shall be weatherproof and provided with 4-1/2" dials, 1/4" or 1/2" threaded connections, and black phenolic resin, black Pocan, or epoxy coated aluminum cases with safety glass windows. Gauge socket and internal component materials shall be compatible with the process medium. As a minimum, gauge sockets and internal components (including bourdon tubes and tips, bellows, or diaphragms) shall be constructed of Type 316L stainless steel. Gauges shall be suitable for dry or liquid filled operation. Gauge accuracy shall be ±0.5% of span per ASTM B40.1, Grade 2A. Gauge range shall be selected for 150% of the working pressure or vacuum of the monitored medium. Gauge dials shall be provided with white backgrounds and black markings. Gauge units shall be applicable to the medium and pressure and/or vacuum range.

B. Pressure gauges shall be as manufactured by Ashcroft, Wika, Marsh Instruments, or equal.

2.05 DIAPHRAGM SEALS

A. General

Where shown on the Drawings or specified elsewhere, diaphragm seals shall be provided between the process medium and the pressure or vacuum sensing element (e.g. gauge, transmitter, or switch). Diaphragm seals shall be provided with upper and lower housings and diaphragms that are welded or clamped between the housings. Upper and lower housings shall be connected with bolts (4 minimum). Diaphragm seals shall be provided with 1/2" threaded female NPT process connections, 1/4" or 1/2" threaded instrument connections, and lower housings with 1/4" flushing connections. Unless otherwise shown on the Drawings, one (1) diaphragm seal shall be provided for each instrument for direct mounting.

Manufacturer shall be responsible for selecting the diaphragm seal based on each specific instrument assembly, including the diaphragm size, diaphragm
material, diaphragm spring constant, assembly fill fluid medium, assembly fill fluid volume, and connection piping size (if not direct mounted) to maintain a minimum accuracy of ± 1% of full instrument range based on an ambient temperature range of 20°F to 120°F and exposure to direct sunlight. In addition, manufacturer shall be responsible for selecting diaphragm, bottom housing, and gasket materials to be compatible with the process medium. As a minimum, diaphragm, lower housing, upper housing, and bolts shall be constructed of Type 316L stainless steel.

Diaphragm seals shall be as manufactured by Ashcroft, Wika, or equal.

B. Water Service (Potable and Non-Potable)

Diaphragm seals for water service shall be of all Type 316L stainless steel construction, including diaphragm, lower housing, upper housing, and hardware.

C. Chlorine Service (Solution)

Diaphragm seals for chlorine service shall be of all Hastelloy C-276 construction, including diaphragm, lower housing, upper housing, and hardware.

2.06 PRESSURE SWITCHES

A. Pressure switches shall utilize bourdon tubes, diaphragms, or bellows as the sensing/actuating element. Unless otherwise specified, the sensing/actuating element material shall be Type 316 stainless steel. The set point shall be readily field adjustable over the range specified. Switches shall have deadband adjustable up to a maximum of 100% of switch range. Pressure range shall be as indicated on the Drawings. Switches shall be SPDT, rated for 5 A at 240 VAC. Unless specified otherwise, switch enclosures shall be rated NEMA 4X. Switch pressure connection shall be 1/4" FNPT.

B. Pressure switches shall be Model 836 as manufactured by Allen Bradley (no substitutes).

2.07 DIFFERENTIAL PRESSURE SWITCHES

A. Differential pressure switches shall utilize bourdon tubes, diaphragms, or bellows as the sensing/actuating element. Unless otherwise specified, the sensing/actuating element material shall be stainless steel. The set point shall be readily field adjustable over the range specified. Switches shall have deadband adjustable up to a minimum of 50% of switch range. Repeatability
shall be ±1% of range. Switch pressure range shall be as indicated on the Drawings. Switches shall be SPDT, rated for 10 A (minimum) at 240 VAC. Unless specified otherwise, switch enclosures shall be rated NEMA 4X. Switch pressure connections shall be 1/4" FNPT.

B. Differential pressure switches shall be as manufactured by Winters, Ashcroft, or equal.

2.08 PRESSURE TRANSMITTERS

A. Pressure transmitters shall be electronic two wire devices with the following features: adjustable span, zero and damping adjustments, integral indicator scaled in engineering units, solid state circuitry and 4-20 mA output. Accuracy shall be ±0.25% of span. Overrange capacity, without affecting calibration, shall not be less than 150% of maximum range. Process wetted materials shall be compatible with the process fluid, unless specified for installation with a diaphragm seal. Unless specified otherwise, process wetted materials shall be Type 316 stainless steel. Body material shall be Type 316 stainless steel. Transmitter process connection shall be 1/2" NPT. Fill fluid, unless otherwise specified, shall be silicone oil. Transmitter housing shall be epoxy coated low copper aluminum alloy and rated NEMA 4X, unless specified otherwise.

B. Unless specified for direct mounting, pressure transmitters shall be provided with mounting brackets and installation kits. Bracket shall be suitable for surface mounting, pipe mounting, or block and bleed valve manifold mounting. Mounting bracket wetted materials shall be shall be compatible with the process fluid, unless specified for installation with a diaphragm seal. Unless specified otherwise, mounting bracket wetted materials shall be constructed of Type 316 stainless steel. Mounting brackets, installation kits, and accessories shall be provided by the pressure transmitter manufacturer.

C. Pressure transmitters shall be as manufactured by Foxboro (no substitutes).

2.09 DIFFERENTIAL PRESSURE TRANSMITTERS

A. Differential pressure transmitters shall be electronic two wire devices with the following features: adjustable span, zero and damping adjustments, integral indicator scaled in engineering units, solid state circuitry and 4-20 mA output. Accuracy shall be ±0.25% of span. Over-range capacity, without affecting calibration, shall not be less than 150% of maximum range. Span shall be field adjustable over at least a 4 to 1 range. Process wetted materials shall be Type 316 stainless steel. Body material shall be Type 316 stainless steel. Process
connections shall be 1/2" NPT. Fill fluid, unless otherwise specified, shall be silicone oil. Transmitter housing shall be epoxy coated low copper aluminum alloy and rated NEMA 4X, unless specified otherwise. A three (3) valve manifold shall be provided with the transmitter, unless indicated otherwise on the Drawings. Manifold wetted materials shall be Type 316 stainless steel.

B. Differential pressure transmitters shall be provided with mounting brackets and installation kits. Bracket shall be suitable for surface mounting, pipe mounting, or block and bleed valve manifold mounting. Mounting bracket wetted materials shall be shall be compatible with the process fluid, unless specified for installation with a diaphragm seal. Unless specified otherwise, mounting bracket wetted materials shall be constructed of Type 316 stainless steel. Mounting brackets, installation kits, and accessories shall be provided by the differential pressure transmitter manufacturer.

C. Pressure transmitters shall be as manufactured by Foxboro (no substitutes).

2.10 ULTRASONIC LIQUID LEVEL MEASUREMENT SYSTEM

A. General

Ultrasonic liquid level measurement systems shall consist of a microprocessor based electronic controller, a non-contacting transducer, and cable from transducer to controller. The electronic controller shall be capable of receiving, processing, and transmitting ultrasonic signals. All operating parameters shall be entered via the controller keypad. For liquid level, the controller shall, upon demand, display current head, temperature, and distance from transducer to liquid level.

The ultrasonic liquid level measurement system shall be the SITRANS LUT 420 as manufactured by Siemens (no substitutes).

B. Service

The transducer shall be capable of submergence without degradation. Transducer shall function over an ambient temperature range of -40°F to 200°F, and shall be rated by FM and CSA for Class I and II hazardous environments. Controller shall function over an ambient temperature range of 15°F to 122°F.
C. **Performance**

The transducer shall transmit and receive an acoustic signal to accurately measure liquid level over a range of 0' to 50' with a 6° beam angle, unless specified otherwise. Point of zero reference shall be operator adjustable. The output signal shall be proportional to level from 0 to 100% with a resolution of ±0.1%. The transducer shall be provided with integral temperature sensor for speed-of-sound compensation. Unless specified otherwise, the transducer shall be the Model EchoMax XPS-15F as manufactured by Siemens (no substitutes).

D. **Level Measurement Features**

1. Controller shall be provided with output indicating meter with four-character LCD display programmable in engineering units of: feet, inches, or percent of span.

2. The controller shall be single channel, and shall be capable of auto-false echo suppression for fixed obstruction avoidance.

3. Interconnecting Cable: Cable between transducer and controller shall be supplied with unit, and shall be suitable for a maximum system length of 1,000'. Contractor shall verify length of cable required for each specific installation. Cable shall be installed in a single run with no splices. Cable shall be installed in continuously grounded PVC-coated rigid galvanized steel conduit.

4. Discrete Outputs: Controller shall provide up to three (3) discrete outputs, each adjustable over entire scale range.

5. Alarms: Alarms shall be programmable for level, rate of change of level, differential level, or loss of echo.

6. Alarm Messages: Loss of echo and cable circuit open or shorted.

E. **Pump Control Features**

1. Controller shall be provided with output contacts for starting and stopping pumps based on preset, adjustable start level and stop level setpoints. Contacts shall be rated 5A at 250 VAC.

2. Two (2) discrete inputs for backup level override and pump interlock functions.
3. Alternate duty pump routines.

4. Alarm output relay, Form C (SPDT) rated 1A at 250 VAC.

E. Controller Interface

1. Controller Output: 4-20 mA DC output, current isolated, into a maximum of 600 ohms (return to ground).

2. Power Supply: Unit shall operate on 120-Volt, 60 Hz power, unless specified otherwise.

3. Discrete Outputs: Form "C" SPDT relays, 5 amps (continuous), non-inductive, 250 VAC.

4. Controller shall be provided with necessary output functions and communication interfaces to enable implementation of control and monitoring operations as specified in other equipment sections of these Specifications, and/or shown on the Drawings.

F. Controller Enclosure

1. Controller enclosure shall be rated NEMA 4.

2. Unless specified otherwise, indoor controllers shall be wall mounted or panel mounted. Where controller is specified to be panel mounted, it shall be flush mounted in the panel door. ICS shall provide all brackets, supports, bezels, etc. necessary for flush panel mounting.

3. Unless specified otherwise, outdoor controllers shall be provided with stainless steel, sheet metal sun shields (20 gauge, minimum). Sun shields shall be open at the front and bottom, and shall be of sufficient size to allow access to controller for operation and maintenance. Free edges shall be rolled. Sun shields shall be constructed without sharp edges and corners.
2.11 OPERATOR INTERFACE TERMINAL (OIT)

A. General

Operator interface terminals (OITs) shall be suitable for flush mounting on the exterior door of remote terminal unit (RTU) panels. Unless specified otherwise, Contractor shall furnish RTU panel enclosures complete with hinged door, back panel, and door mounted OIT. RTU internal components shall be furnished by the District on the Contractor supplied RTU back panel. Contractor shall install the completed back panel, including District mounted equipment, into the RTU panel enclosure. District will connect the OIT to the RTU internal equipment and program the RTU Kingfisher PLC. Contractor shall install the complete RTU panel as shown on the Drawings, including conduit connections and mounting. Contractor shall connect all field wiring to the RTU terminal blocks in accordance with the interconnection wiring diagrams shown on the Drawings.

B. OIT

OIT shall have a 5.7" TFT 65,536 color screen with resistive type touch screen and 270 cd/m² brightness. OIT shall require 24 VDC power and comply with EN50081-2, EN50082-2, and FCC Class A standards. OIT shall be connected to District's Kingfisher RTU via 8-conductor flat communications cable and software shall be compatible with District's RTU. OIT shall be C-More Touch Panel Part No. EA7-T6CL-R as manufactured by Koyo Electronics (no substitutes).

2.12 ANCILLARY MATERIALS AND COMPONENTS

A. Pipe and Fittings

Unless indicated otherwise on the Drawings, all pressure gauges, pressure switches, and pressure transmitters shall be connected to process piping with Class 150 threaded fittings, Schedule 40 pipe nipples, and isolation ball valve. Unless specified otherwise, all fittings, pipe nipples, and ball valves shall be constructed of Type 316 stainless steel.

B. Block and Bleed Valve Manifolds

Where indicated on the Drawings, pressure transmitters and differential pressure transmitters shall be provided with block and bleed valve manifolds capable of isolating process sensing lines, venting to atmosphere, and connection of test equipment for instrument calibration. Block and bleed valve manifolds shall be 3-valve or 5-valve, as indicated on the Drawings. All wetted
materials shall be compatible with the process fluid. Unless specified otherwise, valves shall be constructed of Type 316 stainless steel. Block and bleed valve manifolds shall be as manufactured by Foxboro, Anderson Greenwood, or equal.

Unless indicated otherwise on the Drawings, block and bleed valve manifolds shall be provided with mounting kits for mounting the manifold and pressure transmitter assembly to a 2” diameter Schedule 40 hot dipped galvanized pipe stanchion.

C. Protective Coatings

All metallic enclosures, except stainless steel, shall be provided with a corrosion resistant factory coating, fusion bonded epoxy or equivalent coating system.

D. Fasteners

Unless indicated otherwise on the Drawings, equipment and appurtenances shall be securely mounted to walls and floors using Type 316 stainless steel wedge anchors or epoxy anchors for masonry and concrete structures, and Type 316 stainless steel machine bolts and lag screws for metal and wood structures (respectively).

PART 3 - EXECUTION

3.01 GENERAL

A. It is the general intent of these Specifications that installation of all instrumentation and control equipment; and supply and installation of all field wiring, conduit, and wiring external to the motor control centers, control panels and electrical equipment shall be performed by the Electrical Subcontractor. The ICS shall furnish all instrumentation and control equipment specified herein and supervise installation by the Electrical Subcontractor. In addition, the ICS shall coordinate design of controls within motor control center(s), control panels and electrical equipment, and ensure compatibility of design with equipment and equipment systems.

B. The ICS's attention is directed to the electrical and mechanical details of this project. Referral to these portions of the Contract Documents shall be required in order to understand the full intent and scope of work required.
3.02 INSTALLATION

A. General

1. All instrumentation and control equipment shall be installed in accordance with the manufacturer’s written instructions, NEC standards, requirements and standards specified herein, and as shown on the Drawings.

2. Wiring between process instruments and remote mounted signal converters/controllers shall conform to the manufacturer’s recommended cable type and procedures.

3. All instrumentation and control equipment shall be grounded per manufacturer’s requirements. Contractor shall coordinate grounding between process instruments and remote mounted signal converters/controllers, and electrical ground system to ensure compliance with the manufacturer’s recommended grounding procedures.

4. Minimum process connection size for pressure gauges, switches, and transmitters shall be 1/2" NPT. Provide threaded reducers and 1/4" diameter nipples to transition from 1/2" diameter process connection appurtenances to 1/4" device pressure connections.

5. Unless indicated otherwise on the Drawings, all pressure gauges, pressure switches, and pressure transmitters shall be connected to process piping with Class 150 threaded fittings, Schedule 40 pipe nipples, and isolation ball valve. Unless specified otherwise, all fittings, pipe nipples, and ball valves shall be constructed of Type 316 stainless steel.

B. Pressure Gauges

1. Pressure gauges shall be liquid filled (fill fluid as selected by manufacturer), except where diaphragm seals are specified.

2. For diaphragm seal installations with lower housing constructed of materials other than Type 316 stainless steel, all pipe fittings, pipe nipples, and isolation ball valves shall be constructed of the same material as the diaphragm seal lower housing.
C. **Pressure Switches**

1. Pressure switches shall be provided with Type 316 stainless steel pulsation dampeners, except where diaphragm seals are specified.

2. For diaphragm seal installations with lower housing constructed of materials other than Type 316 stainless steel, all pipe fittings, pipe nipples, and isolation ball valves shall be constructed of the same material as the diaphragm seal lower housing.

D. **Pressure Transmitters**

1. Direct connected pressure transmitters shall be provided with Type 316 stainless steel pulsation dampeners, except where diaphragm seals or block and bleed valve manifolds are specified.

2. For diaphragm seal installations with lower housing constructed of materials other than Type 316 stainless steel, all pipe fittings, pipe nipples, and isolation ball valves shall be constructed of the same material as the diaphragm seal lower housing.

3. Bracket mounted pressure transmitters and bracket mounted pressure transmitters with block and bleed valve manifolds shall be mounted to 2” diameter Schedule 40 hot dipped galvanized pipe stanchions with stainless steel U-bolts. Each stanchion shall be provided with 3/8” thick steel base plate and four 3/8” diameter anchor bolts for floor mounting.

E. **Differential Pressure Transmitters**

1. Where indicated on the Drawings, differential pressure transmitters shall be provided with block and bleed valve manifolds. Block and bleed valve manifolds shall be in furnished accordance with the requirements specified herein.

2. For diaphragm seal installations with lower housing constructed of materials other than Type 316 stainless steel, all pipe fittings, pipe nipples, and appurtenances shall be constructed of the same material as the diaphragm seal lower housing.

3. Unless indicated otherwise on the Drawings, differential pressure transmitter brackets or manifolds shall be mounted to 2” diameter Schedule 40 hot dipped galvanized pipe stanchions with stainless steel U-
bolts. Each stanchion shall be provided with 3/8” thick steel base plate and four 3/8” diameter anchor bolts for floor mounting.

4. Connections from process piping to differential pressure transmitter brackets or block and bleed valve manifolds shall be Schedule 40 piping as specified herein, or Type 316 stainless steel tubing (0.035” wall thickness) with compression (Swagelok) fittings.

F. Float Switches

1. Unless indicated otherwise on the Drawings, float switches shall be provided with stainless steel clamps and appurtenances suitable for mounting switches to a vertical 3/4-inch pipe.

2. Vertical pipe shall be accessible by District personnel without entering the structure and shall be capable of being easily removed for float cleaning and adjustment.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Engineering Representative

The services of manufacturer's engineering representative especially trained and experienced in the installation of the equipment shall be provided to supervise the installation, be present when the instruments and equipment are first put into operation, and inspect, check, adjust as necessary, and calibrate the instruments. All costs for representative's services shall be included in the Contract Price.

B. Calibration

1. Unless specified otherwise, each field instrument shall be calibrated after installation, in conformance with the requirements specified herein and the instrument manufacturer's instructions. Those components having adjustable features shall be set for the specific conditions and applications of the project, and shall be within the specified limits of accuracy.

2. Each field instrument shall be calibrated at 0%, 25%, 50%, 75%, and 100% of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 5 times greater than the specified accuracy of the instrument being calibrated. Test instruments shall have
accuracies traceable to the National Institute of Standards and Technology (NIST).

3. A calibration sheet shall be prepared for each instrument recording all calibration readings, including the readings as finally adjusted within the specified tolerances. Contractor shall submit a written report to the District on each instrument. The report shall include the field calibration sheet for each instrument, and associated manufacturer’s standard calibration sheet (if applicable).

4. Elements and equipment which cannot achieve proper calibration or accuracy, either individually or within a system, shall be replaced.

C. Certify Proper Installation

After all installation and connection work has been completed, the ICS and manufacturer’s representative shall check it all for correctness, verifying polarity of electric power and signal connections, making sure all process connections are free of leaks, and all other similar details. The ICS and manufacturer's representative shall certify in writing that for each loop or system checked out, that equipment is properly installed, setup, calibrated, and is ready for operation. Refer to Part 1.08C herein for ICS Certification.

3.04 FIELD TESTING

A. Operational Demonstration Testing

Contractor shall demonstrate that the performance of installed instrumentation and control equipment and materials complies with specified requirements. Equipment shall be operated through its full range for not less than 2 hours unless a longer period is specified elsewhere. Immediately correct defects and malfunctions with approved methods and materials in each case, and repeat the demonstration. Operational demonstration testing shall conform to the approved startup, initial operation and demonstration testing plan.
B. **Field Operation Tests**

Unless specified otherwise, test all instrumentation and control systems for not less than 24 hours, with no interruptions except for normal maintenance. Field operation tests shall conform to the approved test plan.

1. **Testing Materials and Equipment**

Contractor shall furnish all labor, equipment, and materials for required tests, including all test instruments, recorders, gauges, chemicals, power, etc.

2. **Testing Methods**

Contractor shall perform field tests on equipment as specified in the Special Conditions and/or Detailed Provisions for the specific equipment. Unless specified otherwise, operate systems continuously for a minimum of 24 hours. Cause equipment to cycle through the applicable range of operation at a steady rate of change. Induce simulated alarm and distressed operating conditions, and test controls and protective devices for correct operation in adjusting system functions or causing system shutdown.

3. **Defects**

Contractor shall immediately correct all defects and malfunctions disclosed by tests. Contractor shall use new parts and materials as required to perform corrective work, as approved by the District. The specified total test period shall be extended by the interruption time for corrective work.

4. **Test Records**

Contractor shall continuously record all function and operation parameters during the entire test period. Contractor shall submit complete, well organized, and clearly labeled test data to the District for review and approval.

3.05 **INSTRUCTION**

District's personnel shall be instructed in the functions and operation of each system and shall be shown the various adjustable and set point features which may require re-
adjustment, resetting or checking, re-calibration, or maintenance by them from time to time. Instruction shall include interactions of the systems, operations, shutdowns, alarms, failure, and controls. This instruction shall be scheduled at a time arranged with the District at least two (2) weeks in advance. Instruction shall be classroom type for a minimum of four (4) hours, or as specified by the Special Conditions. Instruction shall be given by the ICS and other qualified persons who have been made familiar in advance with the systems in this Facility.
Appendix A

APPROVED MATERIALS LIST
(Capital & Developer Projects)

UPDATED
10.19.2018
Eastern Municipal Water District

Approved Materials List

TABLE OF CONTENTS

Purpose and General Notes

I. GENERAL 4
1. BACKFLOW PREVENTION & DETECTOR ASSEMBLIES ........................................... 5
2. FIRE HYDRANTS ....................................................................................................... 6
3. GASKETS & GROMMETS ....................................................................................... 8
4. METER BOXES & VAULTS ..................................................................................... 9
5. METERS & METER COMPONENTS ....................................................................... 11
6. NUTS & BOLTS ..................................................................................................... 13
7. PAINT SCHEDULE ................................................................................................. 14
8. SERVICE SADDLES & TAPPING SLEEVES .......................................................... 15
9. UNDER-GROUND UTILITY MARKING TAPE ....................................................... 18
10. WATER PIPE & TUBING ..................................................................................... 19

II. FITTINGS 21
1. BRASS SERVICE FITTINGS ................................................................................... 22
2. DUCTILE IRON FITTINGS ..................................................................................... 24
3. FLANGES ................................................................................................................ 25
4. FLEX COUPLINGS & FLEXIBLE EXPANSION JOINTS ........................................ 26
5. PIPELINE FITTINGS ............................................................................................. 27
6. VICTaulIC COUPLINGS & FITTINGS .................................................................. 29
7. WELDED STEEL FITTINGS ................................................................................... 30

III. VALVES 31
1. AIR VALVES ........................................................................................................... 32
2. APPURtenances ..................................................................................................... 33
3. BALL VALVES ........................................................................................................ 34
4. BUTTERFLY VALVES ........................................................................................... 35
5. CHECK VALVES .................................................................................................... 36
6. CONTROL VALVES .............................................................................................. 37
7. GATE VALVES ....................................................................................................... 39
8. PLUG VALVES ....................................................................................................... 42

IV. SEWER 43
1. MANHOLES & CLEAN-OUTs ................................................................................ 44
2. SEWER PIPE & FITTINGS .................................................................................... 46

V. ELECTRICAL 48
1. WIRING & BASIC ELECTRICAL MATERIALS ....................................................... 49
Purpose and General Notes

The purpose of the Approved Materials List is to streamline the materials submittal and review process during construction. Contractors are strongly encouraged to use materials from the Approved Materials List as these will be expedited and do not require a full technical submittal for review by the District prior to material approval, except for pipe submittals. All pipe materials shall be submitted for review and approval. However, Contractors must submit and identify that materials to be used comply with the approved list and/or current Specifications.

Use of “or equal” materials will require a formal and complete submittal subject to review by the Materials Approval Committee (MAC) prior to approval. Any schedule delays as a result of a submittal or use of “or equal” materials will be the sole responsibility of the Contractor.

In the event of a conflict between approved/contract drawings and the Approved Materials List, the approved/contract drawings shall take precedence.

All materials used for potable water systems must meet California Health and Safety Code 116875 (previously AB1953). All materials that come into contact with potable water must be NSF certified or approved (http://www.nsf.org/). All potable water material submittals must include evidence of NSF certification. Please contact staff if any Model numbers listed are out of date or no longer available.

Vendors and Manufacturers wishing to add materials or products to the Approved Materials List shall follow the Vendor Submittal Requirements (http://www.emwd.org/home/showdocument?id=2980) to make a formal submittal to the MAC. Please contact staff for more information.
I. GENERAL
# 1. BACKFLOW PREVENTION & DETECTOR ASSEMBLIES

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Double Check Assemblies (¾” thru 10”) (For Non-Toxic Service)</td>
<td>AMES, FEBCO</td>
</tr>
<tr>
<td>2. Double Check Detector Assemblies (¾” thru 10”) Std. Dwg. No. B-657</td>
<td>MUELLER, PRATT-WATTS, WILKINS</td>
</tr>
<tr>
<td>(For Automatic Sprinkler Systems Containing Non-Toxic Substance)</td>
<td></td>
</tr>
<tr>
<td>3. R.P. – Reduced Pressure Assemblies (¾” thru 10”) (For High Hazard Service)</td>
<td></td>
</tr>
<tr>
<td>4. R.P. – Reduced Pressure Detector Assemblies (2 ½” thru 10”)</td>
<td></td>
</tr>
<tr>
<td>(For Automatic Fire Sprinkler Systems Containing Toxic Substances)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Backflow prevention materials and detector assemblies shall be one of the above listed manufacturers and shall be listed per latest edition of USC-Foundation for Cross-Connection Control and Hydraulic Research “List of Approved Backflow Prevention Assemblies” A web link to the USC list is located at:

[http://www.usc.edu/dept/fccchr/list.html](http://www.usc.edu/dept/fccchr/list.html)
## 2. FIRE HYDRANTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. BLOW-OFF HYDRANT</strong></td>
<td>JONES</td>
</tr>
<tr>
<td>Model: J-344 – 4” x 1-2 ½”</td>
<td>(EMWD Std. Drawings B-568 &amp; B-561)</td>
</tr>
<tr>
<td>Model: J-342 – 2” x 1-2 ½”</td>
<td>(EMWD Std. Drawing B-374)</td>
</tr>
<tr>
<td><strong>2. BREAK-OFF CHECK VALVE</strong></td>
<td>LONG BEACH IRON WORKS</td>
</tr>
<tr>
<td>Model: 400 (for special locations only as determined by Water Operations)</td>
<td></td>
</tr>
<tr>
<td><strong>3. INTERMEDIATE HYDRANT</strong></td>
<td>CLOW</td>
</tr>
<tr>
<td>6” x 2-2 ½”</td>
<td>Model: Clow Rich Ranger 945</td>
</tr>
<tr>
<td>Std. Drawings B-360 &amp; B-354</td>
<td>JONES</td>
</tr>
<tr>
<td>Model: J-3720</td>
<td></td>
</tr>
<tr>
<td><strong>4. STANDARD HYDRANT</strong></td>
<td>AVK</td>
</tr>
<tr>
<td>6” x 1-4” x 12 ½”</td>
<td>Model: 70 (24-70) Series 24</td>
</tr>
<tr>
<td>Std. Drawings B-362 &amp; B-356</td>
<td>CLOW</td>
</tr>
<tr>
<td>Model: El Rancho 2050 Bronze</td>
<td>Model: Ranger 850</td>
</tr>
<tr>
<td>Model: F850, F860 Cast Iron</td>
<td>JONES</td>
</tr>
<tr>
<td>Model: J-3700 Bronze</td>
<td>Model: J-4040, J-4060 Cast Iron</td>
</tr>
<tr>
<td><strong>LONG BEACH IRON</strong></td>
<td></td>
</tr>
<tr>
<td>Model: Series 125 Bronze (New Pattern)</td>
<td>Model: 611 East Bay</td>
</tr>
</tbody>
</table>
## 2. FIRE HYDRANTS

### 2 of 2

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5. SUPER HYDRANT</strong></td>
<td></td>
</tr>
<tr>
<td>6” x 1-4” x 2-2 ½”</td>
<td>AVK</td>
</tr>
<tr>
<td>Std. Drawings B-516 &amp; B-517</td>
<td>Model: 90 (24-90) Series 24</td>
</tr>
<tr>
<td></td>
<td>CLOW</td>
</tr>
<tr>
<td></td>
<td>Model: El Rancho 2060 Bronze</td>
</tr>
<tr>
<td></td>
<td>Model: 860</td>
</tr>
<tr>
<td></td>
<td>JONES</td>
</tr>
<tr>
<td></td>
<td>Model: J-3765 Bronze</td>
</tr>
<tr>
<td></td>
<td>LONG BEACH IRON</td>
</tr>
<tr>
<td></td>
<td>Model: LBIW 615</td>
</tr>
<tr>
<td></td>
<td>Model: Series 130 Bronze (New Pattern)</td>
</tr>
<tr>
<td><strong>6. WARFHEAD HYDRANT</strong></td>
<td>JONES</td>
</tr>
<tr>
<td>4” x 1-2 ½”</td>
<td>Model: J-344 HP</td>
</tr>
<tr>
<td>Std. Drawings B-368 &amp; B-357</td>
<td></td>
</tr>
</tbody>
</table>
### 3. GASKETS & GROMMETS  
**Detailed Provisions Section 15081**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hand Hole Liner Grommets</td>
<td>DIVE/CORR, INC.</td>
</tr>
<tr>
<td>For reservoir roof openings</td>
<td></td>
</tr>
<tr>
<td>2. Meter Gaskets</td>
<td>JONES</td>
</tr>
<tr>
<td>For water meter installations</td>
<td></td>
</tr>
<tr>
<td>Model 136: ¾” x 1/16” Leather Meter Washers</td>
<td></td>
</tr>
<tr>
<td>Model 137: 1” x 1/16” Leather Meter Washers</td>
<td></td>
</tr>
<tr>
<td>1 ½” &amp; 2” Rubber-Cloth-Inserted Drop-In Meter Gasket</td>
<td></td>
</tr>
<tr>
<td>3. Ring and Full Face Gaskets</td>
<td>GARLOCK</td>
</tr>
<tr>
<td>Gaskets for steel and cast iron flanges shall conform to the requirements</td>
<td></td>
</tr>
<tr>
<td>of EMWD Std. Drawing B-288 and shall be standard full face for pipe 27”</td>
<td>TRIPAC</td>
</tr>
<tr>
<td>diameter and larger.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Style 5000, non-asbestos</td>
</tr>
</tbody>
</table>

8 of 50 PAGES
## 4. METER BOXES & VAULTS

### 1 of 2

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Meter Boxes</strong></td>
<td></td>
</tr>
<tr>
<td>Concrete or Polymer</td>
<td></td>
</tr>
<tr>
<td>Concrete EMWD Std. Drawing</td>
<td>EISEL ENTERPRISES (H &amp; C)</td>
</tr>
<tr>
<td>B-590, B-591, B-342, B-344</td>
<td>17” x 30” Model No. 666B</td>
</tr>
<tr>
<td></td>
<td>30” x 48” Model No. 68MB</td>
</tr>
<tr>
<td></td>
<td>J &amp; R CONCRETE</td>
</tr>
<tr>
<td></td>
<td>12” x 20” Model No. 4 ½ (No. 37) Polymer Concrete</td>
</tr>
<tr>
<td></td>
<td>13” x 24” Model No.W5 ¼ P (No.38) Polymer Concrete</td>
</tr>
<tr>
<td></td>
<td>17” x 30” Model No. 6B</td>
</tr>
<tr>
<td></td>
<td>30” x 48” Model No. 8</td>
</tr>
<tr>
<td></td>
<td>BROOKS PRODUCTS</td>
</tr>
<tr>
<td></td>
<td>17” x 30” Model No. 66</td>
</tr>
<tr>
<td></td>
<td>30” x 48” Model No. 68</td>
</tr>
<tr>
<td></td>
<td>ARMORCAST PRODUCTS</td>
</tr>
<tr>
<td></td>
<td>12” x 20” A6000485SA (No.37) ½” Polymer Concrete</td>
</tr>
<tr>
<td></td>
<td>13” x 24” A6001946PC-12 (No.38) 1” Polymer Concrete</td>
</tr>
<tr>
<td></td>
<td>ASSOCIATED CONCRETE PRODUCTS</td>
</tr>
<tr>
<td></td>
<td>12” x 20” Cat #WPB111812C21 (#437) Polymer Concrete</td>
</tr>
<tr>
<td></td>
<td>Cat #WPC1118RLC11</td>
</tr>
<tr>
<td></td>
<td>13” x 24” Cat #WPB132412A21 (#438) Polymer Concrete</td>
</tr>
<tr>
<td></td>
<td>Cat #WPC1324RLC11</td>
</tr>
<tr>
<td><strong>2. Meter Box Lid Covers</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>J&amp;R CONCRETE</td>
</tr>
<tr>
<td></td>
<td>Domestic Meter Box Lid Covers (PC 412 QRP)</td>
</tr>
<tr>
<td></td>
<td>ARMOR CAST PRODUCTS</td>
</tr>
<tr>
<td></td>
<td>Domestic Meter Box Lid Covers (A6000484-H1)</td>
</tr>
</tbody>
</table>
### 4. METER BOXES & VAULTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. Utility Vaults</strong></td>
<td>BROOMS CONCRETE PRODUCTS</td>
</tr>
<tr>
<td>SIZE</td>
<td>#W-300 Series</td>
</tr>
<tr>
<td></td>
<td>#W-500 Series</td>
</tr>
<tr>
<td></td>
<td>#W-510 Series</td>
</tr>
<tr>
<td></td>
<td>#W-600 Series</td>
</tr>
<tr>
<td></td>
<td>#W-610 Series</td>
</tr>
<tr>
<td></td>
<td>#W-680 Series</td>
</tr>
<tr>
<td><strong>4. Valve Boxes</strong></td>
<td>BROOMS CONCRETE PRODUCTS</td>
</tr>
<tr>
<td></td>
<td>#1-RD</td>
</tr>
<tr>
<td></td>
<td>#1-RT</td>
</tr>
<tr>
<td></td>
<td>#3-RT</td>
</tr>
<tr>
<td></td>
<td>#4-TT</td>
</tr>
<tr>
<td></td>
<td>#1-SP</td>
</tr>
<tr>
<td><strong>5. Vaults</strong></td>
<td>BEST CONCRETE PRODUCTS</td>
</tr>
<tr>
<td></td>
<td>Models MCT-4 and MCT-5</td>
</tr>
</tbody>
</table>
### Meters & Meter Components

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>Compound Meters</strong>&lt;br&gt;3” thru 6” (cubic feet register)</td>
<td>SENSUS TECH. INC.&lt;br&gt;Omni C-2 (AMI/AMR Sensus Flex Net, ERC Register)</td>
</tr>
<tr>
<td>2. <strong>Electromagnetic Meter</strong>&lt;br&gt;4” thru 10” (domestic) (cubic feet register)</td>
<td>SENSUS TECH. INC.&lt;br&gt;Model Series DRFS &amp; CFS (Must be with ECR 2 or 3 registers &amp; Absolute Encoder Technology)</td>
</tr>
<tr>
<td>3. <strong>Fire Service Meters</strong>&lt;br&gt;(Cubic feet registers)&lt;br&gt;strainer required</td>
<td>ENDRESS &amp; HAUSER&lt;br&gt;Promag 53 W Electromagnetic FlowmeterRemote Mounted Transmitter&lt;br</td>
</tr>
</tbody>
</table>

All meters must be grounded in accordance with manufacturer’s recommendations.
## 5. METERS & METER COMPONENTS

### 5. Multi-Jet Water Meter

**AWWA (cubic-feet register) Std. Drawings B-590, B-591, B-342, & B-344**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multi-Jet Water Meter</strong></td>
<td><strong>MASTER METER</strong></td>
</tr>
<tr>
<td>¾” x ¾”: BLO5-2VA-NAA-2 MJ Meters with Acculinx Registers, Lead Free Body with Plastic Bottom, Cubic Feet W/Sensus 520m TP6 Potted</td>
<td>1½” BLO5-2VA-NNA-2 MJ. Meters with Acculinx Registers, Lead Free Body w/Plastic Bottom, Cubic Feet W/Sensus 520M TP6 Potted</td>
</tr>
<tr>
<td>1” meter: BLO5-2VA-NNA-2 MJ. w/Acculinx register, Lead Free Body w/bronze bottom, CCF registration, w/Sensus 520MP TP6 Potted</td>
<td>1½” meter: MJ11-2VA-NNA-2 w/Acculinx register. Lead Free Body w/bronze bottom, CCF registration, w/Sensus 520M TP6 Potted.</td>
</tr>
<tr>
<td>2” meter: MJ13-2VA-NNA-2 w/Acculinx register. Lead Free Body w/bronze bottom, CCF registration, w/Sensus 520M TP6 Potted.</td>
<td></td>
</tr>
</tbody>
</table>

### 6. Propeller Flow Meters - Pumping Plants & Agriculture

**Propeller Flow Meters (ECR Register AMI/AMR, FlexNet compatible, acre-feet register)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Propeller Flow Meters</strong></td>
<td><strong>MCCROMETER</strong></td>
</tr>
<tr>
<td>MG-900-series</td>
<td><strong>MG-900-series</strong></td>
</tr>
<tr>
<td>MW-900-series</td>
<td><strong>MW-500-series</strong></td>
</tr>
<tr>
<td>SENSUS Tech, Inc. 101</td>
<td><strong>SENSUS Tech, Inc.</strong></td>
</tr>
<tr>
<td>102</td>
<td></td>
</tr>
</tbody>
</table>

### 7. Sports Hydrant Meters

**Sports Hydrant Meters**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sports Hydrant Meters</strong></td>
<td><strong>PERFORMANCE METER INC.</strong></td>
</tr>
<tr>
<td>Model No. FHS20 (Must be with a 2” inch gate valve)</td>
<td></td>
</tr>
</tbody>
</table>

### 8. Turbine Meters

**Turbine Meters**

**A. Landscape**

Strainer required

2” & smaller to have cubic feet registers

3” & larger to have acre feet register

**B. Domestic**

Cubic feet register

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Turbine Meters</strong></td>
<td><strong>SENSUS TECH. INC.</strong></td>
</tr>
<tr>
<td>Model Omni T2 (Turbine) 1.5” thru 6” (ECR Register AMI/AMR Flex Net)</td>
<td><strong>Model No. FHS20 (Must be with a 2” inch gate valve)</strong></td>
</tr>
</tbody>
</table>

**PERFORMANCE METER INC.**

Model No. FHS20 (Must be with a 2” inch gate valve)
# 6. NUTS & BOLTS

## Detailed Provisions Section 15089

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Nuts &amp; Bolts For Flanged Fittings</td>
<td></td>
</tr>
<tr>
<td>Shall be bare steel conforming to SAE-J429 Grade 5 or</td>
<td></td>
</tr>
<tr>
<td>ASTM A449 medium carbon steel quenched and</td>
<td></td>
</tr>
<tr>
<td>tempered, meeting the following requirements, and</td>
<td></td>
</tr>
<tr>
<td>shall have hex heads and lite pattern hex nuts</td>
<td></td>
</tr>
<tr>
<td>¼” thru 1” Diameter</td>
<td></td>
</tr>
<tr>
<td>Proof Strength – 85,000 PSI</td>
<td></td>
</tr>
<tr>
<td>Yield Strength – 92,000 PSI</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength – 120,000 PSI</td>
<td></td>
</tr>
<tr>
<td>1” thru 1 ½” Diameter</td>
<td></td>
</tr>
<tr>
<td>Proof Strength – 74,000 PSI</td>
<td></td>
</tr>
<tr>
<td>Yield Strength – 81,000 PSI</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength – 105,000 PSI</td>
<td></td>
</tr>
<tr>
<td>2. Nuts &amp; Bolts for 1 ½” &amp; 2” Meter Installations</td>
<td></td>
</tr>
<tr>
<td>⅝ x 2 ½” Silicon Bronze Hex head. Bolts w/ Bronze</td>
<td>RELIANCE</td>
</tr>
<tr>
<td>Hex Nuts</td>
<td>MARS</td>
</tr>
<tr>
<td>3. Zinc Caps</td>
<td></td>
</tr>
</tbody>
</table>
## 7. PAINT SCHEDULE

<table>
<thead>
<tr>
<th>Item</th>
<th>Color*</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aerator &amp; Clarifier Spray Headers, Effluent Pumps, &amp; Piping</td>
<td>OSHA Safety Red</td>
<td>Sherwin-Williams</td>
</tr>
<tr>
<td>2. Air Valve Assemblies</td>
<td>Koala Bear</td>
<td></td>
</tr>
<tr>
<td>3. Chlorine</td>
<td>OSHA Safety Orange</td>
<td></td>
</tr>
<tr>
<td>4. Electrical</td>
<td>White</td>
<td></td>
</tr>
<tr>
<td>5. Fire Hydrants</td>
<td>OSHA Safety Yellow</td>
<td></td>
</tr>
<tr>
<td>6. Fire Hydrant Tops and Nozzle Caps</td>
<td>Red = 500 gpm or less, Orange = 500-999 gpm, Green = 1000-1499 gpm, Light Blue = 1500 gpm or greater</td>
<td></td>
</tr>
<tr>
<td>7. Natural Gas Pipe</td>
<td>OSHA Safety Yellow</td>
<td></td>
</tr>
<tr>
<td>8. Hydrogen Peroxide (H₂O₂) Equipment</td>
<td>OSHA Safety Yellow</td>
<td></td>
</tr>
<tr>
<td>9. High &amp; Low Pressure Air</td>
<td>OSHA Safety Green</td>
<td></td>
</tr>
<tr>
<td>10. Oil</td>
<td>Black</td>
<td></td>
</tr>
<tr>
<td>11. Potable Water – Pumps, Piping and Appurtenances</td>
<td>Pale Blue / Desert Tan</td>
<td></td>
</tr>
<tr>
<td>12. Reclaimed Water – Piping and Appurtenances</td>
<td>Pantone Purple #513 C or #522 C</td>
<td></td>
</tr>
<tr>
<td>13. Sludge Sewage - Pumps, Piping, and Appurtenances</td>
<td>Rich Brown</td>
<td></td>
</tr>
<tr>
<td>14. Steam Lines</td>
<td>Pale Blue</td>
<td></td>
</tr>
<tr>
<td>15. Water Storage Tanks</td>
<td>Fawn / Buffalo</td>
<td></td>
</tr>
<tr>
<td>16. Water Valve Caps</td>
<td>Pale Blue</td>
<td></td>
</tr>
</tbody>
</table>

*Color shall be selected by Engineering Department staff such that facility blends in with the surroundings (existing terrain) or to ensure permit requirements/conditions of approval are satisfied.
8. **SERVICE SADDLES & TAPPING SLEEVES**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. *Service Saddles for A.C. Pipe 4” thru 12”</td>
<td>JONES</td>
</tr>
<tr>
<td></td>
<td>Model: J-975</td>
</tr>
<tr>
<td></td>
<td>Model: J-979</td>
</tr>
<tr>
<td>2. Service Saddle for C-900 Pipe ¾” thru 2”</td>
<td>CAMBRIDGE BRASS</td>
</tr>
<tr>
<td></td>
<td>Model: 800 Series Hinged Bronze Saddle</td>
</tr>
<tr>
<td>3. *Service Saddles for C-900 Pipe 4” thru 12”</td>
<td>JONES</td>
</tr>
<tr>
<td></td>
<td>Model: J-996-R</td>
</tr>
<tr>
<td></td>
<td>Model: J-996</td>
</tr>
<tr>
<td></td>
<td>McDONALD</td>
</tr>
<tr>
<td></td>
<td>Model: 3805</td>
</tr>
<tr>
<td></td>
<td>MUELLER</td>
</tr>
<tr>
<td></td>
<td>Model: H-13000</td>
</tr>
<tr>
<td></td>
<td>ROMAC IND.</td>
</tr>
<tr>
<td></td>
<td>Model: B-101</td>
</tr>
<tr>
<td></td>
<td>Model: B-202</td>
</tr>
<tr>
<td></td>
<td>FORD</td>
</tr>
<tr>
<td></td>
<td>Model: S902 and S912 (Style B2 piece bolted design)</td>
</tr>
<tr>
<td>4. *Service Saddles for Ductile Iron Pipe 4” thru 36”</td>
<td>FORD</td>
</tr>
<tr>
<td></td>
<td>Model: F-101</td>
</tr>
<tr>
<td></td>
<td>Model: F-202</td>
</tr>
<tr>
<td></td>
<td>ROMAC IND.</td>
</tr>
<tr>
<td></td>
<td>Model: Romac 101</td>
</tr>
<tr>
<td></td>
<td>Model: Romac 202</td>
</tr>
<tr>
<td></td>
<td>SMITH-BLAIR</td>
</tr>
<tr>
<td></td>
<td>Model: Rockwell 311</td>
</tr>
<tr>
<td></td>
<td>Model: Rockwell 313</td>
</tr>
</tbody>
</table>

*Note: Size 10” & above require double-strap service saddles.*
8. SERVICE SADDLES & TAPPING SLEEVES

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Service Saddles for Steel Pipe Connections</td>
<td>INTERNATIONAL FABRICATORS</td>
</tr>
<tr>
<td></td>
<td>NORTHWEST PIPE COMPANY (AMERON)</td>
</tr>
<tr>
<td></td>
<td>SOUTHLAND PIPE CO.</td>
</tr>
<tr>
<td></td>
<td>WEST COAST PIPE</td>
</tr>
<tr>
<td>Weld Saddles 1 - ¼” x 4” thru 48”</td>
<td></td>
</tr>
<tr>
<td>Weld Saddles 2 - ½” x 4” thru 48”</td>
<td></td>
</tr>
<tr>
<td>Refer to Std. Drawing B-271</td>
<td></td>
</tr>
<tr>
<td>6. Tapping Sleeves for A.C., PVC, &amp; D.I.</td>
<td>FORD PRODUCTS</td>
</tr>
<tr>
<td>4” thru 24”</td>
<td>Model: Fast-Sleeve” 18-8 All Stainless Steel</td>
</tr>
<tr>
<td></td>
<td>JCM IND.</td>
</tr>
<tr>
<td></td>
<td>Model: JCM-432 All Stainless Steel</td>
</tr>
<tr>
<td></td>
<td>Model: JCM-452 All Stainless Steel (14” &amp; above)</td>
</tr>
<tr>
<td></td>
<td>POWERSEAL PRODUCTS</td>
</tr>
<tr>
<td></td>
<td>Model: 3490 All Stainless Steel</td>
</tr>
<tr>
<td></td>
<td>ROMAC IND.</td>
</tr>
<tr>
<td></td>
<td>Model: SST 18-8 All Stainless Steel</td>
</tr>
<tr>
<td></td>
<td>SMITH BLAIR. INC.</td>
</tr>
<tr>
<td></td>
<td>Model: 663 (4” thru 24”)</td>
</tr>
<tr>
<td></td>
<td>Model: 665 (6” thru 12”)</td>
</tr>
<tr>
<td></td>
<td>ROBAR</td>
</tr>
<tr>
<td></td>
<td>Model: 6606</td>
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</table>
### 8. SERVICE SADDLES & TAPPING SLEEVES

#### 7. Weld Saddles
- Std. Drawing B-271

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy, Coated Fabricated Steel Outlet Scotch 3M – #206N</td>
<td>INTERNATIONAL FABRICATORS</td>
</tr>
<tr>
<td>Schedule 40 Pipe on 4” thru 10”</td>
<td>NORTHWEST PIPE COMPANY (AMERON)</td>
</tr>
<tr>
<td>¼” Wall Pipe on 12” &amp; above</td>
<td>SOUTHLAND PIPE CO.</td>
</tr>
<tr>
<td></td>
<td>WEST COAST PIPE</td>
</tr>
</tbody>
</table>
9. **UNDER-GROUND UTILITY MARKING TAPE**  
(Non-Detectable Only)

<table>
<thead>
<tr>
<th>Description</th>
<th>Color Code: A.P.W.A.</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAFETY BLUE – Potable Water Systems</td>
<td>REEF INDUSTRIES Terra Tape</td>
</tr>
<tr>
<td></td>
<td>SAFETY GREEN – Sanitary and Storm Sewer Systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SAFETY ORANGE – Telephone, Cable &amp; Telegraph Systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SAFETY PURPLE – Reclaimed Water Lines</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SAFETY RED – Electric Power &amp; Systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SAFETY YELLOW – Gas &amp; Oil</td>
<td></td>
</tr>
</tbody>
</table>

Underground utility marking tape shall be in accordance with the A.P.W.A. National Color Code and shall be imprinted with an appropriate legend to define the type of utility line it protects.

Tape shall be of a pigmented polyolefin film with a printed message on one side. The ink used to print the materials shall be permanent and cannot be removed by normal handling or upon underground burial.

The polyethylene shall be chemically inert and shall not degrade when exposed to alkalies, acids, and other destructive substances commonly found in soils.

Tape shall consist of a 4.0 mil overall thickness or as approved by Engineering.
## 10. WATER PIPE & TUBING

### WATER PIPE

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ductile Iron Pipe</td>
<td>PACIFIC STATES&lt;br&gt;U.S. PIPE</td>
</tr>
<tr>
<td><strong>Detailed Provisions Section 15057</strong>&lt;br&gt;AWWA C-600, C-151, C-150, &amp; C-104</td>
<td><strong>J-M MANUFACTURING COMPANY, INC.</strong>&lt;br&gt;CHEVRON PHILLIPS CHEMICAL COMPANY</td>
</tr>
<tr>
<td>2. High Density Polyethylene Pipe</td>
<td><strong>J-M MANUFACTURING COMPANY, INC.</strong>&lt;br&gt;CHEVRON PHILLIPS CHEMICAL COMPANY</td>
</tr>
<tr>
<td>3. High Density Polyethylene Pipe</td>
<td><strong>J-M MANUFACTURING COMPANY, INC.</strong>&lt;br&gt;CHEVRON PHILLIPS CHEMICAL COMPANY</td>
</tr>
<tr>
<td>4. Polyvinyl Chloride (PVC)</td>
<td><strong>CARLON PIPE</strong>&lt;br&gt;CERTAIN-TEED CORP.&lt;br&gt;JOHN-MANSVILLE CO. – “JM”&lt;br&gt;NORTH AMERICAN PIPE CORP.&lt;br&gt;PW PIPE CO.&lt;br&gt;VINYL-TECH – “White Knight”&lt;br&gt;DIAMOND PLASTICS CORP. 4” thru 24”</td>
</tr>
<tr>
<td><strong>Detailed Provisions Section 15064</strong>&lt;br&gt;4” thru 36” – C900</td>
<td><strong>CONTINENTAL PIPE MAN</strong>&lt;br&gt;ROSCOE MOSS&lt;br&gt;MID AMERICA PIPE&lt;br&gt;NORTHWEST PIPE COMPANY (AMERON)&lt;br&gt;WEST COAST PIPE</td>
</tr>
<tr>
<td>5. Steel Pipe (Bare)</td>
<td><strong>CONTINENTAL PIPE MAN</strong>&lt;br&gt;ROSCOE MOSS&lt;br&gt;MID AMERICA PIPE&lt;br&gt;NORTHWEST PIPE COMPANY (AMERON)&lt;br&gt;WEST COAST PIPE</td>
</tr>
<tr>
<td>3” thru 10” – standard wall thickness&lt;br&gt;12” thru 54”, ¼” wall thickness minimum&lt;br&gt;<strong>Steel Certification Required</strong></td>
<td><strong>CONTINENTAL PIPE MAN</strong>&lt;br&gt;ROSCOE MOSS&lt;br&gt;MID AMERICA PIPE&lt;br&gt;NORTHWEST PIPE COMPANY (AMERON)&lt;br&gt;WEST COAST PIPE</td>
</tr>
<tr>
<td>6. Steel Pipe (CML&amp;C)</td>
<td><strong>CONTINENTAL PIPE MAN</strong>&lt;br&gt;ROSCOE MOSS&lt;br&gt;MID AMERICA PIPE&lt;br&gt;NORTHWEST PIPE COMPANY (AMERON)&lt;br&gt;WEST COAST PIPE</td>
</tr>
<tr>
<td><strong>Detailed Provisions Section 15061</strong>&lt;br&gt;AWWA C-200, C-205 &amp; C-303 (all classes)&lt;br&gt;4” thru 54”</td>
<td><strong>CONTINENTAL PIPE MAN</strong>&lt;br&gt;ROSCOE MOSS&lt;br&gt;MID AMERICA PIPE&lt;br&gt;NORTHWEST PIPE COMPANY (AMERON)&lt;br&gt;WEST COAST PIPE</td>
</tr>
</tbody>
</table>
### 9. WATER PIPE & TUBING

#### TUBING

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Copper Tubing – Type K Soft Water Service Installations ASTM B-88 ¾ thru 2”</td>
<td></td>
</tr>
<tr>
<td>2. Copper Tubing – Type L Rigid Backflow Installations ASTM B-88 ¾ thru 3”</td>
<td></td>
</tr>
<tr>
<td>3. Liner Insert (Stainless Steel)</td>
<td>FORD CO. #72 JONES CO. J-2806 MUELLER CO. #505142 MCDONALD #6136</td>
</tr>
<tr>
<td>4. Polyethylene Water Service Pipe 1”</td>
<td>DRISCO #5100 Ultraline WESTFLEX Gold Label – Class 200</td>
</tr>
</tbody>
</table>
II. FITTINGS
# 1. BRASS SERVICE FITTINGS

Std. Drawings B-590 – B-591A
1” thru 2” B-342 – B344B

## Appendix A

<table>
<thead>
<tr>
<th>Item</th>
<th>Item</th>
<th>CAMBRIDGE</th>
<th>FORD</th>
<th>JONES</th>
<th>MCDONALD</th>
<th>MUELLER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ¾-BEND (90 Ell)</td>
<td>105 (Series)</td>
<td>L04-44-NL L06-44-NL C04-44-NL C06-44-NL L84-44-NL L86-44-NL C86-44-NL F250</td>
<td>J-1548 J-1550</td>
<td>4776-22 4761-22</td>
<td>H-15530 H-15068</td>
<td></td>
</tr>
<tr>
<td>5. Liner Inserts</td>
<td>Ford-72</td>
<td>J-2806</td>
<td>61362</td>
<td>Full Circle 316 SS #505142</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Meter Bushings 1 ¾” x 1”</td>
<td>FORD-34-NL</td>
<td>J-128H</td>
<td>4134-239</td>
<td>H-10889</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Meter Flange</td>
<td></td>
<td>J-129</td>
<td>610-F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Meter Tail Piece (Meter Couplings)</td>
<td></td>
<td>J-130 J-134</td>
<td>4622 4624</td>
<td></td>
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</tr>
</tbody>
</table>

ASTM – 43 Copper Service
## 1. BRASS SERVICE FITTINGS

Std. Drawings B-590 – B-591A
1” thru 2” B-342 – B344B

<table>
<thead>
<tr>
<th>Item</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Splicing Couplings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CAMBRIDGE</td>
</tr>
<tr>
<td></td>
<td>FORD</td>
</tr>
<tr>
<td></td>
<td>JONES</td>
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<td>MCDONALD</td>
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<td></td>
<td>MUELLER</td>
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<td>C44-44-NL</td>
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<td>C22-66-NL</td>
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<td>C44-66-NL</td>
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<td>H-15403</td>
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<td></td>
<td>H-15456</td>
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ASTM – 43 Copper Services
## 2. DUCTILE IRON FITTINGS

**Detailed Provisions Section 15057**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fittings shall be Ductile Iron and shall conform to ANSI/AWWA C153 / A21.53, ANSI/AWWA C111/A21.11, and ANSI/AWWA C110/A21.10.</td>
<td>ONE BOLT, INC.</td>
</tr>
<tr>
<td>Fittings shall be Mechanical Joints or Push-on Joints.</td>
<td>ASTM / A536 Restraint Joint</td>
</tr>
<tr>
<td>Fittings shall be Tar (seal) coated and Cement Mortar lined per ANSI A21.4 (AWWA C104).</td>
<td>PACIFIC STATES</td>
</tr>
<tr>
<td></td>
<td>PIPELINE COMPONENTS, INC.</td>
</tr>
<tr>
<td></td>
<td>M.J. Compact Fittings – All Sizes</td>
</tr>
<tr>
<td></td>
<td>M.J. Full Body Fittings – All Sizes</td>
</tr>
<tr>
<td></td>
<td>Push On Fittings – 4” thru 8”</td>
</tr>
<tr>
<td></td>
<td>SERAMPORE INDUSTRIES PRIVATE LTD, INC.</td>
</tr>
<tr>
<td></td>
<td>SIP Industries C110 MJ</td>
</tr>
<tr>
<td></td>
<td>SIGMA CORPORATION</td>
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<td>Sigma/Nappco</td>
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<tr>
<td></td>
<td>STAR PIPE PRODUCTS</td>
</tr>
<tr>
<td></td>
<td>TYLER UNION</td>
</tr>
<tr>
<td></td>
<td>TufGrip Dual Wedge, Series 1500</td>
</tr>
<tr>
<td></td>
<td>U.S. PIPE</td>
</tr>
</tbody>
</table>

24 of 50 PAGES
### FLANGES

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
</table>
| 1. Companion Flange  
Cast Iron, Threaded | JONES  
Model: J-129. Size: 1 ½” & 2” |
| 2. Ring Flange  
Std. Drawing B-288  
1 ½” thru 54” | RETECH INC. & CONTINENTAL MANUFACTURING  
No. A-36 Steel Ring Flange  
No. A-283 “C” Steel Flange  
No. A-283 “D” Steel Flange |
| 3. Meter Flange  
Bronze  
Std. Drawing B-342 thru B-344-B | MCDONALD  
#610-F. Size: 1 ½” & 2”  
3” Class “D” Plate Flange with four ¾” I.D. Bore  
For use on 3” Compound Meter Connection. |
| 4. Meter Flange  
Steel  
Std. Drawing B-633 | |
## 4. FLEX COUPLINGS & FLEXIBLE EXPANSION JOINTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Flex Couplings (Compression)</td>
<td>FORD METER PRODUCTS</td>
</tr>
<tr>
<td>Steel &amp; Cast Iron</td>
<td>Model: F-Ringwall Series</td>
</tr>
<tr>
<td>½” thru 36”</td>
<td>ROMAC</td>
</tr>
<tr>
<td></td>
<td>Model: Romac 501 Series</td>
</tr>
<tr>
<td></td>
<td>Model: Macro HP 4” thru 12”</td>
</tr>
<tr>
<td></td>
<td>Alpha Series</td>
</tr>
<tr>
<td></td>
<td>SMITH-BLAIR</td>
</tr>
<tr>
<td></td>
<td>Model: SB-411, SB-441</td>
</tr>
<tr>
<td>2. Flex Expansion Joints</td>
<td>EBBA IRON</td>
</tr>
<tr>
<td>3” thru 36”</td>
<td>Flex-tend</td>
</tr>
<tr>
<td>min. offset: 11” for ≤ 12” diameter</td>
<td></td>
</tr>
<tr>
<td>min. offset: 18” for &gt; 12” diameter</td>
<td></td>
</tr>
</tbody>
</table>
## 5. PIPELINE FITTINGS

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Joint Restraints</td>
<td>EBAA IRON</td>
</tr>
<tr>
<td></td>
<td>2000 PV Series: 4” thru 24” (C-900)</td>
</tr>
<tr>
<td></td>
<td>Model 1100 Series: 3” thru 48”</td>
</tr>
<tr>
<td></td>
<td>2100 Series: 4” thru 12” (C-900)</td>
</tr>
<tr>
<td></td>
<td>2800 Series: 14” thru 36” (C-900)</td>
</tr>
<tr>
<td></td>
<td>FORD</td>
</tr>
<tr>
<td></td>
<td>Uni-flange Series Model 200, 900,1300 &amp; 1400</td>
</tr>
<tr>
<td></td>
<td>Uni-flange Series Model 1500 restraint joint for PVC pipe 4” thru 12”</td>
</tr>
<tr>
<td></td>
<td>Uni-flange Series Model 1390 restraint joint for PVC pipe</td>
</tr>
<tr>
<td></td>
<td>NAPPCO/SIGMA CORP.</td>
</tr>
<tr>
<td></td>
<td>Model PV-Lok PVM: 2” thru 12”</td>
</tr>
<tr>
<td></td>
<td>Model PV-Lok PVP: 2” thru 12”</td>
</tr>
<tr>
<td></td>
<td>Model ONE LOK: 4” thru 36”</td>
</tr>
<tr>
<td></td>
<td>ROMAC INDUSTRIES</td>
</tr>
<tr>
<td></td>
<td>Grip Ring 4” thru 12”</td>
</tr>
<tr>
<td></td>
<td>Alpha Restrained Joints 4” thru 12”</td>
</tr>
<tr>
<td></td>
<td>Flanged Coupling Adaptor, Coupling, and End Cap</td>
</tr>
<tr>
<td></td>
<td>SIP INDUSTRIES</td>
</tr>
<tr>
<td></td>
<td>EZ-Grip</td>
</tr>
<tr>
<td></td>
<td>SMITH BLAIR</td>
</tr>
<tr>
<td></td>
<td>Model C111/C120</td>
</tr>
<tr>
<td></td>
<td>STAR</td>
</tr>
<tr>
<td></td>
<td>Allgrip 3600: 4” thru 12” for C900 and ductile iron pipe</td>
</tr>
<tr>
<td></td>
<td>Series 1000: 4” thru 12” for C900</td>
</tr>
<tr>
<td></td>
<td>Series 1100: 4” thru 48” for C900 PVC Grip 3500: 4” thru 16” for C-900</td>
</tr>
<tr>
<td></td>
<td>Stargrip 3000: 4” thru 36” for D.I.P.</td>
</tr>
<tr>
<td></td>
<td>PVC Stargrip 4000: 4” thru 36” for C900</td>
</tr>
<tr>
<td></td>
<td>U.S. PIPE</td>
</tr>
<tr>
<td></td>
<td>Field Lok Gaskets: 4” thru 12”</td>
</tr>
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</table>
## 5. PIPELINE FITTINGS

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Pipeline Adapters</td>
<td>CERTAIN-TEED CORP.</td>
</tr>
<tr>
<td></td>
<td>ROBAR</td>
</tr>
<tr>
<td></td>
<td>Models 1506, 1508, 1908</td>
</tr>
<tr>
<td></td>
<td>ROMAC IND.</td>
</tr>
<tr>
<td></td>
<td>Model 500 Series</td>
</tr>
<tr>
<td></td>
<td>Alpha Series</td>
</tr>
<tr>
<td></td>
<td>SIGMA CORP.</td>
</tr>
<tr>
<td></td>
<td>Model Sigma/NAPPCO</td>
</tr>
<tr>
<td></td>
<td>SMITH-BLAIR</td>
</tr>
<tr>
<td></td>
<td>Model SB-900 Series</td>
</tr>
<tr>
<td></td>
<td>TYLER UNION</td>
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</table>
### 6. VICTAULIC COUPLINGS & FITTINGS

**Detailed Provisions Section 15077**, Std. Drawing No. A-192

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
</table>
| 1. Grooved Victaulic Couplings and Fittings | **GUSTIN-BACON**
Model: 100-IPS
Model: 500-Ductile Iron

**VICTAULIC CO.**
Style 31 – Coupling - 3” to 36”
Style 307 – Transition Coupling – 3” to 12”
Style 341 – Flange Adaptor – 3” to 24”
Style 107N – QuickVic Rigid Coupling – 2” to 12”
Style 177N – QuickVic Flexible Coupling – 2” to 12”
Style W07 – AGS Rigid Coupling – 14” to 50”
Style W77 – AGS Flexible Coupling – 14” to 72”
  w/ Grade “E” Gasket
Style W741 – AGS Vic-Flange Adapter |
### 7. WELDED STEEL FITTINGS

**Detailed Provisions Section 15059**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Steel Fittings</td>
<td></td>
</tr>
<tr>
<td>Domestic Steel</td>
<td></td>
</tr>
<tr>
<td>Various Sizes</td>
<td></td>
</tr>
<tr>
<td>Shall be fabricated as shown on the contract drawings, and/or as specified in the Special Conditions.</td>
<td></td>
</tr>
<tr>
<td>Flanges shall conform to the requirements of EMWD Std. Drawing B-288 made a part hereof by reference.</td>
<td></td>
</tr>
<tr>
<td><strong>Steel Certification Required</strong></td>
<td></td>
</tr>
</tbody>
</table>
III. VALVES
### 1. AIR VALVES

**Detailed Provisions Section 15136**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Air Release Valve 3/4”</td>
<td>APCO VALVE CO. Model: APCO #65</td>
</tr>
<tr>
<td></td>
<td>CLA-VAL CO. Model: 361-CAV564B and 362-CAV332</td>
</tr>
<tr>
<td></td>
<td>CRISPIN VALVE CO. Model: UL-10 and UL-20</td>
</tr>
<tr>
<td></td>
<td>EMPIRE VALVE CO. Model: 940</td>
</tr>
<tr>
<td></td>
<td>VALVMATIC VALVE CO. Model: 201C and 202C</td>
</tr>
<tr>
<td>3. Air Release and Vacuum Valve Std. Drawing B-578 4” &amp; 6”</td>
<td>APCO VALVE CO. Model: 149-C and 150-C</td>
</tr>
<tr>
<td></td>
<td>CLA-VAL CO. Model: 364-CAV332 and 366-CAV732-3</td>
</tr>
<tr>
<td></td>
<td>CRISPIN VALVE CO. Model: UL-41 (4”) and AL-61/PL-10 (6”)</td>
</tr>
<tr>
<td>5. Pump Air Valve</td>
<td>ARMSTRONG MACHINE WORKS – Model: 21</td>
</tr>
</tbody>
</table>
## 2. APPURTEANCES

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hose Bibbs (Brass) 300-lbs working water pressure For Treatment Plants</td>
<td>CALIFORNIA BRASS MFG. CO. Calco Fig. 101 FAIRBANKS VALVE CO. Model: 150-S</td>
</tr>
</tbody>
</table>
## 3. BALL VALVES
### Detailed Provisions Section 15104

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ball Valves</td>
<td>LUNKENHEIMER COMPANY</td>
</tr>
<tr>
<td>AWSA C507</td>
<td>MARPAC, INC.</td>
</tr>
<tr>
<td></td>
<td>VALVE TECHNOLOGY CO.</td>
</tr>
<tr>
<td></td>
<td>Models: D7410 – 7420 Series</td>
</tr>
<tr>
<td></td>
<td>Models: D7421 – 7432 Series</td>
</tr>
<tr>
<td>2. Meter Ball Valves (with Handles)</td>
<td>A.Y. MCDONALD</td>
</tr>
<tr>
<td></td>
<td>Model: 6101 MWH (¾” and 1”)</td>
</tr>
<tr>
<td></td>
<td>JAMES JONES CO.</td>
</tr>
<tr>
<td></td>
<td>Jones Model: J1908W (¾” and 1”)</td>
</tr>
<tr>
<td></td>
<td>THE FORD METER BOX CO., INC.</td>
</tr>
<tr>
<td></td>
<td>Model: B13-332 W (¾”)</td>
</tr>
<tr>
<td></td>
<td>Model: B13-444 (1”)</td>
</tr>
</tbody>
</table>
## 4. BUTTERFLY VALVES

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
</table>
| 1. Class 150  
**Detailed Provisions Section 15103**  
AWWA C-504  
Coatings: valves shall have all ferrous parts epoxy coated per AWWA-C550 (fusion bonded) | AMERICAN FLOW CONTROL  
Model: A.D. 150 Size: 4”-48”  
CLOW CO.  
Model: Clow BFV. Class 150, Size: 4” thru 72”  
CRISPIN (Previously CMB Industries)  
K-FLO Model: 500 Series, 3” thru 20”  
K-FLO Model: 47 Series, 24” thru 48”  
DEZURIK CO.  
Model: Dezurik BFV. Class 150, Size: 4” thru 20”  
KENNEDY  
Model: Kennedy BFV. Class 150 Size: 4” thru 72”  
KUBOTA  
Model: Kubota BFV. Class 150, Size: 24” thru 48”  
M & H CO.  
Model: 4500, Class 150, Size 4” thru 24”  
Model: 1450, Class 150B, Size 30” thru 48”  
MUELLER CO.  
Model: Mueller Lineseal III, Size: 4” thru 24”  
Model: Mueller Lineseal III, Size: 30” thru 48” (with Ductile Iron Disc.)  
PRATT VALVE CO.  
Model: Pratt Ground Hog BFV. Class 150 with no Power Operation Allowed, Size: 4” thru 12”  
Model: Pratt Ground Hog with Power operation allowed with knowledge of turns. Size: 14” thru 48”  
Model: Pratt Triton XR-70 with Handwheel. Size: 24” thru 48” |
| 2. Class 250  
Coatings: valves shall have all ferrous parts epoxy coated per AWWA-C550 (fusion bonded) | CRISPIN (Previously CMB Industries)  
Model: K-FLO 500 Series  
DEZURIK  
Model: BAW Series  
PRATT  
Model: H.P. 250 |
5. **CHECK VALVES**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bronze Threaded Swing Check Valve ¾” thru 2”</td>
<td>HAMMOND VALVE CO.</td>
</tr>
<tr>
<td></td>
<td>Model: 946 Bronze</td>
</tr>
<tr>
<td></td>
<td>MILWAUKEE VALVE CO.</td>
</tr>
<tr>
<td></td>
<td>Model: 510 &amp; 511</td>
</tr>
<tr>
<td></td>
<td>STOCKHAM VALVE CO.</td>
</tr>
<tr>
<td></td>
<td>Model: B-320</td>
</tr>
<tr>
<td>2. Flanged Swing Check Valves shall be single disc type with spring and lever when so specified on the Bidding Sheet.</td>
<td>APCO VALVE CO.</td>
</tr>
<tr>
<td></td>
<td>CLOW CO.</td>
</tr>
<tr>
<td></td>
<td>KENNEDY VALVE CO.</td>
</tr>
<tr>
<td></td>
<td>M &amp; H CO.</td>
</tr>
<tr>
<td></td>
<td>MUELLER CO./PRATT</td>
</tr>
<tr>
<td></td>
<td>STOCKHAM CO.</td>
</tr>
<tr>
<td>3. Wafer Check Valve w/Viton O-Ring Seal 4 thru 12”</td>
<td>PENTAIR</td>
</tr>
<tr>
<td></td>
<td>Keystone Prince Figure No. 810 &amp; Figure No. 813-S &amp; L Short Wafer Body</td>
</tr>
<tr>
<td></td>
<td>Keystone Prince Figure No. F810-004</td>
</tr>
<tr>
<td></td>
<td>Keystone Prince Figure No. F813-519-S&amp;L</td>
</tr>
</tbody>
</table>
### 6. CONTROL VALVES
**Detailed Provisions Section 15120**

#### 1. Control Valves

All control valves shall be flanged diaphragm type globe valves, with Cast-Iron Body, as manufactured by CLA-VAL Co., or approved equal. Epoxy shall be Thermo-Setting, Conforming to AWWA C-550. Delrin Stem. All Control Valves other than pressure reducing valves shall have Bronze Trim. Pressure Reducing Valves shall have Stainless Steel Trim.

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control Valves</td>
<td>CLA-VAL CO.</td>
</tr>
</tbody>
</table>

#### 2. Pressure Regulators

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Pressure Regulators</td>
<td>AMES CO.</td>
</tr>
<tr>
<td></td>
<td>Model: Ames 900 Series</td>
</tr>
<tr>
<td></td>
<td>Model: Ames 800 Series</td>
</tr>
<tr>
<td></td>
<td>CLA-VAL CO. Model: Clayton 90 Series</td>
</tr>
<tr>
<td></td>
<td>Model: Clayton 610 Series</td>
</tr>
<tr>
<td></td>
<td>PRATT/WATT CO. Model: Globe</td>
</tr>
<tr>
<td></td>
<td>Fig. 115 – Class 125</td>
</tr>
<tr>
<td></td>
<td>Fig. 1115 – Class 250</td>
</tr>
<tr>
<td></td>
<td>WATT CO. Model: Watts 25 AUB, Bronze</td>
</tr>
<tr>
<td></td>
<td>WILKINS Model: Wilkins, 600 Cold Water &amp; Air</td>
</tr>
</tbody>
</table>
### 6. CONTROL VALVES

**Detailed Provisions Section 15120**

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3. Pressure Relief Valves</strong></td>
<td>AMES CO. Model: Ames 800 Series</td>
</tr>
<tr>
<td></td>
<td>CLA-VAL Model: Series 50 &amp; 51</td>
</tr>
<tr>
<td><strong>4. Pump Control Valves</strong></td>
<td>AMES Model Ames 800 Series</td>
</tr>
<tr>
<td></td>
<td>CLA-VAL Model: 61-G</td>
</tr>
<tr>
<td></td>
<td>PRATT/WATTS Model: Globe 513, Class 125</td>
</tr>
<tr>
<td></td>
<td>Model: Angle 1513, Class 250</td>
</tr>
</tbody>
</table>
### 7. **GATE VALVES**

Std. Drawing Nos. B-590 thru B-344-B  
1 of 3

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
</table>
| 1. Bronze Threaded NRS-½”                        | HAMMOND VALVE CO.  
Model: 606-125 PSI  
MILWAUKEE VALVE CO.  
Model: 105-200 PSI  
STOCKHAM VALVE CO.  
Model: B-103-200 PSI |
| 2. Bronze Threaded NRS ¾” thru 1”                | AMERICAN VALVE CO.  
Model: Milano, M-300  
FAIRBANKS VALVE  
Model: 125-S 250  
*F&F VALVE  
Model: 710-Brass  
*KITZ VALVE  
Code No. 27 Fig. AKH  
MILWAUKEE VALVE  
Model: 1105M & #105  
NIBCO VALVE  
Model: T-113-Domestic  
*PIONEER ENTERPRISES  
Model: GTI-0102 & 0103  
RED AND WHITE VALVE  
Model: 206  
STOCKHAM VALVE  
Model: B-103  
WOLVERINE VALVE  
Model: 50293 |

*To be used in customer side of meter installation only. Std. Drawing B-591*
7. **GATE VALVES**

Std. Drawing Nos. B-590 thru B-344-B

2 of 3

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Bronze Threaded NRS 1 ½” thru 2”</td>
<td><strong>AMERICAN VALVE</strong></td>
</tr>
<tr>
<td></td>
<td>Model: 3-F Bronze</td>
</tr>
<tr>
<td></td>
<td><strong>MILWAUKEE VALVE</strong></td>
</tr>
<tr>
<td></td>
<td>Model: 1105M &amp; 105</td>
</tr>
<tr>
<td></td>
<td><strong>NIBCO VALVE</strong></td>
</tr>
<tr>
<td></td>
<td>Model: T-113, Domestic</td>
</tr>
<tr>
<td></td>
<td><strong>STOCKHAM VALVE</strong></td>
</tr>
<tr>
<td></td>
<td>Model: B-103</td>
</tr>
<tr>
<td>4. Cast Iron With 2” Operating Nuts for 2” Blow-offs</td>
<td><strong>CLOW VALVE CO.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>IOWA VALVE</strong></td>
</tr>
<tr>
<td></td>
<td>Model: List 14</td>
</tr>
<tr>
<td></td>
<td><strong>MUELLER VALVE</strong></td>
</tr>
<tr>
<td></td>
<td>Model: A-2380-8 &amp; A-2380-6</td>
</tr>
<tr>
<td></td>
<td><strong>RENSSELSER VALVE</strong></td>
</tr>
<tr>
<td></td>
<td>Model: Ludlow, list 13A</td>
</tr>
<tr>
<td></td>
<td><strong>STOCKHAM VALVE CO.</strong></td>
</tr>
<tr>
<td>5. Flange x Hub End Resilient Gate Valves AWWA C-509</td>
<td>Ring-tite, Fluid-tite, or Approved Equal</td>
</tr>
<tr>
<td>6. Horizontal, Double-Disc Iron Body Bronze-Mounted (IBBM) with Bypass 24”</td>
<td><strong>AMERICAN FLOW SYSTEMS</strong></td>
</tr>
<tr>
<td></td>
<td>Model: A.D. “50-Line”</td>
</tr>
<tr>
<td></td>
<td><strong>CLOW VALVE CO.</strong></td>
</tr>
<tr>
<td></td>
<td>Model: Clow F5070</td>
</tr>
<tr>
<td></td>
<td><strong>MUELLER VALVE CO.</strong></td>
</tr>
<tr>
<td></td>
<td>Model: A-2380-6</td>
</tr>
</tbody>
</table>
## 7. GATE VALVES

Std. Drawing Nos. B-590 thru B-344-B

### 3 of 3

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Resilient Seat Gate Valves Flanged AWWA C-509, C-515 and AWWA C-550</td>
<td>ACIPCO</td>
</tr>
<tr>
<td><strong>EMWD Detailed Provisions Section 15102</strong></td>
<td>Model: 82-200W-77785-7</td>
</tr>
<tr>
<td>4” thru 36”</td>
<td>AMERICAN AVK CO.</td>
</tr>
<tr>
<td></td>
<td>Model: 25 AVK</td>
</tr>
<tr>
<td></td>
<td>AMERICAN FLOW CONTROL CO.</td>
</tr>
<tr>
<td></td>
<td>Model: AFC-500 for 4” thru 12”</td>
</tr>
<tr>
<td></td>
<td>Or Series 2500 for 4” thru 36”</td>
</tr>
<tr>
<td></td>
<td>CLOW CO.</td>
</tr>
<tr>
<td></td>
<td>Model: Clow RW, Class 150</td>
</tr>
<tr>
<td></td>
<td>KENNEDY</td>
</tr>
<tr>
<td></td>
<td>Model: Kennedy RS-Class 150</td>
</tr>
<tr>
<td></td>
<td>M &amp; H</td>
</tr>
<tr>
<td></td>
<td>Model: M &amp; H #A-4067</td>
</tr>
<tr>
<td></td>
<td>MUELLER CO.</td>
</tr>
<tr>
<td></td>
<td>Model: A-2360</td>
</tr>
<tr>
<td></td>
<td>STOCKHAM CO.</td>
</tr>
<tr>
<td></td>
<td>Model: Stockham #G700-0</td>
</tr>
<tr>
<td></td>
<td>TYLER</td>
</tr>
<tr>
<td></td>
<td>Model: DRS 250</td>
</tr>
<tr>
<td></td>
<td>U.S. PIPE</td>
</tr>
<tr>
<td></td>
<td>Model: Metroseal, RS Class 150</td>
</tr>
<tr>
<td></td>
<td>WATEROUS CO.</td>
</tr>
<tr>
<td></td>
<td>Model: Waterous #AFC-500</td>
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</table>
# 8. PLUG VALVES

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Eccentric Fullport Non-Lubricated Plug Valves</td>
<td><strong>DEZURIK</strong> Model: G Series</td>
</tr>
<tr>
<td>3” thru 24”</td>
<td><strong>HENRY PRATT CO.</strong></td>
</tr>
<tr>
<td></td>
<td>Pratt Keystone 580 Series, #898</td>
</tr>
</tbody>
</table>
IV. SEWER
## 1. MANHOLES & CLEAN-OUTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Clean-Outs (Residential)</strong></td>
<td><strong>BROOKS PRODUCTS</strong></td>
</tr>
<tr>
<td></td>
<td>Model: 1-RD</td>
</tr>
<tr>
<td></td>
<td><strong>CHRISTY CONCRETE PRODUCTS</strong></td>
</tr>
<tr>
<td></td>
<td>Model: F8</td>
</tr>
<tr>
<td></td>
<td><strong>EISEL ENTERPRISES</strong></td>
</tr>
<tr>
<td></td>
<td>Model: 1VB-VC</td>
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<tr>
<td></td>
<td><strong>J&amp;R CONCRETE</strong></td>
</tr>
<tr>
<td></td>
<td>Model: V1-R</td>
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<tr>
<td></td>
<td><strong>LONG BEACH IRON WORKS</strong></td>
</tr>
<tr>
<td></td>
<td>Model: Apex</td>
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</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Manhole Covers &amp; Frames</strong></td>
<td><strong>ALHAMBRA FOUNDRY</strong></td>
</tr>
<tr>
<td>24” &amp; 36”</td>
<td>Model: A-1251 &amp; A-1254</td>
</tr>
<tr>
<td>Std. Drawing SB-61</td>
<td><strong>EVERETT ENTERPRISES</strong></td>
</tr>
<tr>
<td></td>
<td>Model: GTS – Pont-A-Mousson</td>
</tr>
<tr>
<td>Note: Cast Iron Lid To Be</td>
<td><strong>FAMEX FOUNDRY</strong></td>
</tr>
<tr>
<td>Marked “EMWD Sewer”</td>
<td>Model: F-1251 &amp; F-1254</td>
</tr>
<tr>
<td></td>
<td><strong>NATIONAL CASTING CORP.</strong></td>
</tr>
<tr>
<td></td>
<td>Model: NC-2531</td>
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<tr>
<td></td>
<td><strong>NEENAH FOUNDRY</strong></td>
</tr>
<tr>
<td></td>
<td>Model: R-1593</td>
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<tr>
<td></td>
<td><strong>NORFOLK CASTING CORP</strong></td>
</tr>
<tr>
<td></td>
<td>Model: NC-254</td>
</tr>
<tr>
<td></td>
<td><strong>RIVERSIDE FOUNDRY</strong></td>
</tr>
<tr>
<td></td>
<td>Model: 1251 &amp; 1254</td>
</tr>
<tr>
<td></td>
<td><strong>SOUTHBAY FOUNDRY</strong></td>
</tr>
<tr>
<td></td>
<td>Model: SBF-1251 &amp; 1254</td>
</tr>
<tr>
<td></td>
<td>Model: SBF-1348 with Pick Hole for EMWD Standard</td>
</tr>
<tr>
<td></td>
<td>Drawing SB-30</td>
</tr>
</tbody>
</table>
### 1. MANHOLES & CLEANOUTS

#### 2 of 2

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
</table>
| 3. Manhole Covers & Frames Locking Std. Drawing SB-8 | ALHAMBRA FOUNDRY  
Model: No.A-1175  
FAMEX FOUNDRY  
Model: F-1251  
LONG BEACH IRON WORKS  
Model: RE85R3PD GTS  
NATIONAL CASTING CORP.  
Model: NC-2531  
NEENAH FOUNDRY  
Model: R-1251  
SOUTHBAY FOUNDRY  
Model: SBF-1251 |
| Note: Cast Iron Lid To Be Marked “EMWD Sewer” | |
| 4. Manhole Shafts, Cones, Flat Tops & Grade Rings 24” thru 48” | AMERICAN HIGHWAY PRODUCTS  
AMERICAN PIPE  
ASSOCIATED CONCRETE  
B & W PRECAST CONSTR.  
HOWARD ENTERPRISES  
INLAND CONCRETE  
MANHOLE BUILDERS  
MAR-CON PRODUCTS  
OLSEN PRECAST  
RIALTO CONCRETE  
SAN DIEGO PRECAST  
SOUTHWEST CONCRETE |
| 5. Manhole Steps | SOUTHWEST CONCRETE PRODUCTS  
Model: X040PS  
Model: X038PS |
### 2. SEWER PIPE & FITTINGS

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
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</thead>
<tbody>
<tr>
<td>1. Reinforced Concrete Pipe</td>
<td>AMERON</td>
</tr>
<tr>
<td></td>
<td>HYDRO CONDUIT</td>
</tr>
<tr>
<td></td>
<td>RIALTO PIPE</td>
</tr>
<tr>
<td>2. Sewer Pipe</td>
<td>ARMCO PIPE - (CONTECH)</td>
</tr>
<tr>
<td>Polyvinyl Chloride (PVC) &amp; Acrylonitrile-Butadiene-Styrene (ABS)</td>
<td>CARLON PIPE</td>
</tr>
<tr>
<td></td>
<td>CERTAIN-TEED CORP.</td>
</tr>
<tr>
<td>Fittings and pipe shall be from the same manufacturer when they make both.</td>
<td>DIAMOND PLASTICS CORP.</td>
</tr>
<tr>
<td>If manufacturer only makes pipe, fittings from 2.a. shall be used.</td>
<td>JM EAGLE</td>
</tr>
<tr>
<td></td>
<td>PRIME CONDUIT VYLON</td>
</tr>
<tr>
<td></td>
<td>21” thru 48”</td>
</tr>
<tr>
<td></td>
<td>VINYL TECH</td>
</tr>
<tr>
<td></td>
<td>White Knight</td>
</tr>
<tr>
<td>a. PVC sewer fittings</td>
<td>BUILDING PRODUCTS CO.</td>
</tr>
<tr>
<td>4” thru 8”</td>
<td>JCP Compression Joints</td>
</tr>
<tr>
<td>gravity use only</td>
<td>GPK</td>
</tr>
<tr>
<td></td>
<td>JM EAGLE</td>
</tr>
<tr>
<td></td>
<td>MULTI-FITTINGS CORP.</td>
</tr>
<tr>
<td></td>
<td>TIGRE</td>
</tr>
<tr>
<td></td>
<td>SDR 35 PVC</td>
</tr>
<tr>
<td>b. PVC sewer fittings</td>
<td>SYROCO INC</td>
</tr>
<tr>
<td>4” thru 8”</td>
<td>SDR 35</td>
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## 2. SEWER PIPES & FITTINGS

### 3. Sewer Repair Couplings

<table>
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<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
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<tbody>
<tr>
<td>Mission Rubber PVC</td>
<td>MR56 44 ARC</td>
</tr>
<tr>
<td></td>
<td>MR56 66 ARC</td>
</tr>
<tr>
<td></td>
<td>MR56 88 ARC</td>
</tr>
<tr>
<td></td>
<td>MR56 1212 ARC</td>
</tr>
<tr>
<td>Clay</td>
<td>MR01 44 ARC</td>
</tr>
<tr>
<td></td>
<td>MR01 66 ARC</td>
</tr>
<tr>
<td></td>
<td>MR01 88 ARC</td>
</tr>
<tr>
<td></td>
<td>MR01 1212 ARC</td>
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### 4. Tapping Saddle

<table>
<thead>
<tr>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>JOINTS COUPLINGS</td>
<td>TAP-N-TEE</td>
</tr>
<tr>
<td></td>
<td>(Conditional/Emergency use only)</td>
</tr>
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</table>

### 5. Vitrified Clay Pipe (VCP)

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Products Co.</td>
<td>JCP Compression Joints</td>
</tr>
<tr>
<td>Gladding McBean Co.</td>
<td>“Speed-Seal”</td>
</tr>
<tr>
<td>Pacific Clay Products</td>
<td>“Band-Seal”</td>
</tr>
<tr>
<td></td>
<td>“Wedgelock”</td>
</tr>
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V. ELECTRICAL
## 1. Wiring & Basic Electrical Materials

<table>
<thead>
<tr>
<th>Description</th>
<th>Manufacturers</th>
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<tbody>
<tr>
<td>1. Insulated CP Test Connections &amp; Blow-Off Connections</td>
<td></td>
</tr>
<tr>
<td>Std. Drawing B-660 &amp; B-662</td>
<td></td>
</tr>
<tr>
<td>#4 HMW – PE (High Molecular Wt-Polyethylene Coated)</td>
<td></td>
</tr>
<tr>
<td>Stranded Wire Black</td>
<td></td>
</tr>
<tr>
<td>#12 TW – Solid Wire – Green or Yellow</td>
<td></td>
</tr>
<tr>
<td>2. Locating Wire</td>
<td></td>
</tr>
<tr>
<td>Std. Drawing B-656</td>
<td></td>
</tr>
<tr>
<td>#14-1 UF Black Copper-Insulated Locating Wire</td>
<td></td>
</tr>
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</table>
### 1. WIRING & BASIC ELECTRICAL MATERIALS

#### 3. Telemetry Cable

**Std. Drawing B-533**

- **Description**: Telemetry wire, double-jacketed, filled polyethylene jacket for burial 5-mil copper shield, solid strand 6-pair, 19-gauge copper wire Alcatel DEDW. (Approximately 5,000 ft. Rolls)

- **Manufacturers**
  - ALCATEL DEDW

- **DISTRIBUTORS**
  - POWER AND TELEPHONE SUPPLY
  - Phone No.: 1-800-451-4381

#### 4. Telemetry Hardware:

- **3M**
  - Splice Kit Model No. 72-N2
  - **CHARLES INDUSTRIES**
  - Pedestal Model No. CPLM8-1/GTE
  - **ENTRELEC**
  - Terminal Model No. M4/6.SNB 0115686.13
  - Terminal End Stop Model No. 114836.00
  - DIN Rail Model No. 101598.26

- **DISTRIBUTORS**
  - **CHARLES INDUSTRIES**
  - Phone No. (847) 806-6300
  - **REXEL ESD ELECTRICAL**
  - Phone No. (760) 747-2211
  - **ROYAL WHOLESALE ELECTRIC**
  - Phone No. (951) 683-6625
<table>
<thead>
<tr>
<th>Photo No(s.)</th>
<th>#</th>
<th>Work Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2</td>
<td>1</td>
<td>Remove existing Lift Station Dry Well structure to a depth of 5' below ground surface. Upon removal of all specified equipment and materials, remaining Dry Well structure shall be filled with sand compacted to 90% relative compaction.</td>
</tr>
<tr>
<td>1, 2, 14</td>
<td>2</td>
<td>Existing Wet Well and manhole to remain, protect in place.</td>
</tr>
<tr>
<td>1, 2, 3</td>
<td>3</td>
<td>Remove Radio Telemetry Unit (RTU) and salvage.</td>
</tr>
<tr>
<td>1, 2, 4</td>
<td>4</td>
<td>Remove below grade valve vault and cover.</td>
</tr>
<tr>
<td>2, 4</td>
<td>5</td>
<td>Remove concrete slab on grade with reinforcement.</td>
</tr>
<tr>
<td>1, 2, 3, 5, 6, 8, 9, 10, 11, 12, 13</td>
<td>6</td>
<td>Remove conduit, conductors, electrical equipment, enclosure, and appurtenances.</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>Remove exhaust fan, supply vent, and appurtenances.</td>
</tr>
<tr>
<td>4, 5, 6, 7, 8, 9, 13</td>
<td>8</td>
<td>Remove piping, valves, fittings, supports, and appurtenances.</td>
</tr>
<tr>
<td>5, 6, 7</td>
<td>9</td>
<td>Remove 5 HP raw sewage pumps, base elbow, and support base and salvage.</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>Remove sump pump.</td>
</tr>
<tr>
<td>6, 9, 10, 11</td>
<td>11</td>
<td>Remove ladder, grating, handrail, and associated supports.</td>
</tr>
<tr>
<td>13</td>
<td>12</td>
<td>Remove fire extinguisher, bracket, and signage.</td>
</tr>
<tr>
<td>14</td>
<td>13</td>
<td>Remove Level Measurement System conduit, conductors, and bubbler tubing. Fill voids in Wet Well wall with non-shrink grout.</td>
</tr>
<tr>
<td>10, 11</td>
<td>14</td>
<td>Remove Manual Transfer Switch and salvage.</td>
</tr>
<tr>
<td>13</td>
<td>15</td>
<td>Remove Pump Nos. 1 and 2 starters, and salvage.</td>
</tr>
<tr>
<td>5, 7, 8</td>
<td>16</td>
<td>After removal of isolation valve, install 4&quot; diameter blind flange.</td>
</tr>
<tr>
<td>8</td>
<td>17</td>
<td>Existing piping to remain, protect in place.</td>
</tr>
</tbody>
</table>
RADIO TELEMETRY UNIT ENCLOSURE
DEMOLITION PHOTOS

PHOTO 6

DRY WELL
LOWER LEVEL
DEMOLITION PHOTOS

PHOTO 12

DRY WELL
UPPER LEVEL
GEOTECHNICAL EXPLORATION
SKINNER I LIFT STATION REPLACEMENT
EASTERN MUNICIPAL WATER DISTRICT (EMWD)
LAKE SKINNER, CALIFORNIA

Prepared for

Krieger & Stewart, Incorporated
3602 University Avenue
Riverside, California 92501-3331

Project No. 12287.001

May 17, 2019
May 17, 2019
Project No. 12287.001

Krieger & Stewart, Incorporated
3602 University Avenue
Riverside, California 92501-3331

Attention: Mr. Egan Strom, PE

Subject:  Geotechnical Exploration
Skinner I Lift Station Replacement
Eastern Municipal Water District (EMWD)
Lake Skinner, California

In accordance with your authorization and our proposal dated November 28, 2018, we are pleased to present herewith the results of our geotechnical exploration for the subject project. Based on the results of our exploration, the proposed lift station is underlain by alluvial deposits consisting primarily of loose to medium dense silty-sand to poorly-graded sand soils. These soils should be considered CalOSHA Type C soils and as such, sloped excavations will be required to protect workers within excavations, if shoring and/or shields are not used. The site is not located within any currently designated County or AP Earthquake Fault Zones. Groundwater was encountered at a depth of approximately 21 below ground surface.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to call our office.

Respectfully submitted,
LEIGHTON CONSULTING, INC.

Simon I. Saiid, GE 2641
Principal Engineer

Robert F. Riha, CEG 1921
Senior Principal Geologist

Distribution: (1) Addressee (email PDF copy)
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0 INTRODUCTION</strong></td>
<td>1</td>
</tr>
<tr>
<td>1.1 SITE AND PROJECT DESCRIPTION</td>
<td>1</td>
</tr>
<tr>
<td>1.2 PURPOSE AND SCOPE</td>
<td>1</td>
</tr>
<tr>
<td>1.3 FIELD EXPLORATION</td>
<td>2</td>
</tr>
<tr>
<td>1.4 LABORATORY TESTING</td>
<td>2</td>
</tr>
<tr>
<td><strong>2.0 GEOTECHNICAL AND GEOLOGIC FINDINGS</strong></td>
<td>3</td>
</tr>
<tr>
<td>2.1 SUBSURFACE CONDITIONS</td>
<td>3</td>
</tr>
<tr>
<td>2.2 SURFACE AND GROUNDWATER</td>
<td>3</td>
</tr>
<tr>
<td>2.3 FAULTING AND SEISMICITY</td>
<td>3</td>
</tr>
<tr>
<td>2.4 SECONDARY SEISMIC HAZARDS</td>
<td>4</td>
</tr>
<tr>
<td><strong>3.0 CONCLUSIONS AND RECOMMENDATIONS</strong></td>
<td>5</td>
</tr>
<tr>
<td>3.1 GENERAL</td>
<td>5</td>
</tr>
<tr>
<td>3.2 EARTHWORK CONSIDERATIONS</td>
<td>5</td>
</tr>
<tr>
<td>3.2.1 Excavation Characteristics</td>
<td>5</td>
</tr>
<tr>
<td>3.2.2 Pipe Subgrade Preparation</td>
<td>5</td>
</tr>
<tr>
<td>3.2.3 Subgrade Preparation</td>
<td>6</td>
</tr>
<tr>
<td>3.2.4 Trench Backfill</td>
<td>6</td>
</tr>
<tr>
<td>3.2.5 Shrinkage and Subsidence</td>
<td>7</td>
</tr>
<tr>
<td>3.3 BEARING CAPACITY AND EARTH Pressures</td>
<td>7</td>
</tr>
<tr>
<td>3.3.1 Bearing Capacity</td>
<td>7</td>
</tr>
<tr>
<td>3.3.2 Soils Parameters for Pipeline Design</td>
<td>8</td>
</tr>
<tr>
<td>3.3.3 External Loads on Pipe by Soil</td>
<td>8</td>
</tr>
<tr>
<td>3.4 RETAINING WALLS DESIGN</td>
<td>9</td>
</tr>
<tr>
<td>3.5 WET WELL DESIGN PARAMETERS</td>
<td>10</td>
</tr>
<tr>
<td>3.6 ASPHALT PAVING</td>
<td>11</td>
</tr>
<tr>
<td>3.7 TEMPORARY CUT SLOPES</td>
<td>11</td>
</tr>
<tr>
<td>3.8 TEMPORARY SHORING</td>
<td>12</td>
</tr>
<tr>
<td>3.9 DEWATERING DURING TRENCHING AND PIPELINE CONSTRUCTION</td>
<td>12</td>
</tr>
<tr>
<td>3.10 CORROSION TESTING</td>
<td>12</td>
</tr>
<tr>
<td>3.11 ADDITIONAL GEOTECHNICAL SERVICES</td>
<td>14</td>
</tr>
<tr>
<td><strong>4.0 LIMITATIONS</strong></td>
<td>15</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>16</td>
</tr>
</tbody>
</table>
LIST OF TABLES

TABLE 1. CBC SITE CATEGORIZATION AND SEISMIC COEFFICIENTS .................................................. 4
TABLE 2. SOIL PARAMETERS FOR PIPE DESIGN ................................................................................ 8
TABLE 3. RETAINING WALL DESIGN EARTH PRESSURES (STATIC, DRAINED) .................................. 9
TABLE 4. RELATIONSHIP BETWEEN SOIL RESISTIVITY AND SOIL CORROSIVITY ..................... 13
TABLE 5. SUMMARY OF CORROSIVITY TESTING ............................................................................. 13

LIST OF FIGURES AND PLATES

Figure 1 – Site Vicinity Map
Figure 2 – Boring Location Plan

LIST OF APPENDICES

Appendix A – Field Exploration / Log of Exploratory Boring and Results of Laboratory Testing
Appendix B – GBA Important Information About This Geotechnical Report
1.0 INTRODUCTION

1.1 Site and Project Description

EMWD is planning to add a new sewage lift station (LS) and associated onsite connecting pipelines. The new LS will be constructed within a close proximity to the existing Skinner No. 1 Lift Station (approximately 8 to 12 feet north) on a relatively gentle slope (~6H:1V). The LS will include a below grade pre-fabricated FRP wet well with a depth of approximately 21 feet (bottom elev. ~1472.73) and associated appurtenances. The proposed LS site/pad is a landscaped slope currently covered with grass and located close to the playground area within the overall Lake Skinner Camp area (see Figure 1). A water pond/lagoon is located approximately 20 feet to the west.

1.2 Purpose and Scope

The purpose of our exploration is to: (1) evaluate geotechnical engineering characteristics of the earth materials, and (2) provide geotechnical recommendations for design and construction of the proposed LS and associated piping. More specifically and as described in our proposal, the scope of our work included the following tasks:

- **Background Review**: We reviewed readily available, relevant, geotechnical/geologic reports and maps pertinent to the project.
- **Field Exploration**: Our field exploration consisted of one (1) hollow-stem auger boring drilled, sampled and logged in an accessible area of the proposed LS.
- **Geotechnical Laboratory Tests**: Geotechnical laboratory tests were performed on selected soil samples collected during our field exploration. This laboratory testing program was designed to evaluate general physical and engineering characteristics of the encountered soils.
- **Engineering Analysis**: Data obtained from our background review, field exploration, and geotechnical laboratory testing program was evaluated to develop geotechnical conclusions and recommendations.
- **Report Preparation**: Results of this evaluation have been summarized in this report, presenting our findings, conclusions and recommendations.

This report does not address the potential for encountering hazardous materials at this site. Important information about limitations of geotechnical reports, in general, is presented in Appendix B, *GBA Important Information About This Geotechnical Report*. 
1.3 Field Exploration

Our field exploration consisted of the excavation of one (1) hollow-stem auger boring in accessible area within the planned LS site. Prior to drilling, we located and marked the boring location for coordination with Underground Service Alert (USA). Approximate location of the boring is depicted on the Boring Location Plan (Figure 2). The exploratory boring was generally excavated in grassy area/slope utilizing a truck-mounted, CME 75 drill rig using 8-inch hollow-stem flight augers. During the drilling operation, bulk and relatively undisturbed samples were obtained from the borings for laboratory testing and evaluation. Sampling of the borings was conducted by a staff geologist from our office. The collected samples were transported to our laboratory for testing. The boring was backfilled with native soils. The log of boring is presented in Appendix A.

1.4 Laboratory Testing

Laboratory tests were performed on representative samples to provide a basis for development of geotechnical conclusions and recommendations. Selected samples were tested to determine the following parameters: insitu moisture and density, maximum dry density and optimum moisture content, sand equivalent, soluble sulfate and chloride content, pH and resistivity. The results of our laboratory testing and summaries of the testing procedures are presented in Appendix A.
2.0 GEOTECHNICAL AND GEOLOGIC FINDINGS

A summary of our findings from research of pertinent literature, site-specific field exploration, geotechnical laboratory testing and engineering analysis, is discussed in this section.

2.1 Subsurface Conditions

Based on the results of our geotechnical exploration, the proposed LS is underlain by alluvial deposits generally consisting of poorly-graded sands (SP-SM) and silty sand soils (SM). This alluvium is generally loose to medium dense with N-values ranging from 8 to 15 blows-per-foot. Based on the results of our laboratory testing on representative samples, the Sand Equivalent (SE) for the underlain soils (SP/SP-SM) is expected to be less than 20. The Expansion Index (EI) of the near surface soil is expected to be less than 21 (very low).

2.2 Surface and Groundwater

Standing water was observed in the adjacent lagoon during our field exploration (estimated at 6 to 8 feet below top of wet well, ~Elev.1493). Shallow groundwater was encountered during our field exploration at a depth of approximately 21 feet BGS. Groundwater should be expected to fluctuate seasonally and be directly-impacted by the adjacent lagoon or other factors not observed at the time of our field explorations.

2.3 Faulting and Seismicity

The subject site, like the rest of Southern California, is located within a seismically active region as a result of being located near the active margin between the North American and Pacific tectonic plates. The principal source of seismic activity on this site is movement along the northwest-trending regional fault systems such as the Lake Elsinore, San Andreas, and San Jacinto. Based on our review of published geologic map (Hart, 2007), the site is not located within an Earthquake Fault Zone as created by the Alquist-Priolo Earthquake Fault Zoning Act.

For the purpose of structural design, seismic coefficients based on the 2016 California Building Code (CBC) are provided below. These seismic coefficients were calculated based on a software program, available on the United States Geological Survey website), which follows the procedures, included in American Society of Civil Engineers (ASCE) Publication ASCE 7-10 and Chapter 16 of 2016 CBC.
Table 1. CBC Site Categorization and Seismic Coefficients

<table>
<thead>
<tr>
<th>Categorization /Coefficient</th>
<th>Coefficient</th>
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<tr>
<td>Site Longitude (decimal degrees)</td>
<td>-117.0394</td>
</tr>
<tr>
<td>Site Latitude (decimal degrees)</td>
<td>33.5870</td>
</tr>
<tr>
<td>Site Class Definition</td>
<td>D</td>
</tr>
<tr>
<td>Mapped Spectral Response Acceleration at 0.2s Period, $S_a$</td>
<td>1.50</td>
</tr>
<tr>
<td>Mapped Spectral Response Acceleration at 1s Period, $S_1$</td>
<td>0.60</td>
</tr>
<tr>
<td>Short Period Site Coefficient at 0.2s Period, $F_a$</td>
<td>1.0</td>
</tr>
<tr>
<td>Long Period Site Coefficient at 1s Period, $F_v$</td>
<td>1.5</td>
</tr>
<tr>
<td>Adjusted Spectral Response Acceleration at 0.2s Period, $S_{MS}$</td>
<td>1.50</td>
</tr>
<tr>
<td>Adjusted Spectral Response Acceleration at 1s Period, $S_{M1}$</td>
<td>0.90</td>
</tr>
<tr>
<td>Design Spectral Response Acceleration at 0.2s Period, $S_{DS}$</td>
<td>1.00</td>
</tr>
<tr>
<td>Design Spectral Response Acceleration at 1s Period, $S_{D1}$</td>
<td>0.60</td>
</tr>
</tbody>
</table>

2.4 Secondary Seismic Hazards

The potential for secondary hazards such as ground rupture, seiches and tsunamis, landsliding, rockfalls, ground fissuring, and liquefaction are considered very low for this site. However, the potential for seismic densification due to the presence of relatively loose alluvium at depth greater than 20 feet should be expected. However, such phenomenon is likely to be regional or over a large area and should have a minimum impact on proposed LS or would have a similar impact as to other structures in this area including existing LS. Mitigation measures to prevent pipe rupture or damage to proposed wet well are generally considered impractical and/or cost prohibitive. Flexible joints and strategically placed shut-off valves are typically installed to reduce damage and allow for speedy repair.
3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 General

The construction of the proposed improvements appear feasible from a geotechnical viewpoint provided that the following recommendations are incorporated into the design and construction phases of development. The soils encountered may be considered CalOSHA Type C soils, and sloped excavations will be required to protect workers, if shoring and/or shields are not used.

3.2 Earthwork Considerations

Earthwork associated with the proposed LS and associated piping should be performed in accordance with applicable EMWD Specifications, “Standard Specifications for Public Works Construction” (GreenBook, latest edition) and the recommendations included in the text of this report.

3.2.1 Excavation Characteristics

Based on the results of our exploratory boring, the onsite alluvium should generally be easy to excavate with conventional earthmoving excavation equipment. Excavation should be performed in accordance with the project plans, specifications, and all applicable OSHA requirements. The contractor should be responsible for providing the "competent person" required by OSHA standards. Contractors should be advised that sandy soils (such as existing, onsite soils) could make excavations particularly unsafe, and hence necessary safety precautions should be taken at all times.

3.2.2 Pipe Subgrade Preparation

Pipe subgrade soils are expected to generally consist of relatively loose to medium dense silty sand. In order to provide adequate seating and support for the proposed pipeline, these materials should be properly compacted to minimum of 90 percent relative compaction per ASTM D1557 or as required per District standard specifications. Where very loose and moist soils are encountered or the subgrade become disturbed due to localized seepage or surface water, the contractor should over-excavate the disturbed or saturated soils to a maximum depth of 2 feet and replace with suitable materials to provide a stable trench bottom. Crushed rock (1-inch maximum size) may be used if found necessary to stabilize bottom of trench prior to placing bedding materials. Placement of filter fabric separation layer may be required due to the granular nature of onsite soils and to provide further stability of the subgrade soils. Any oversize particles larger than 3-inches in largest dimension, if any, within the subgrade, should be removed from the trench bottom and replaced with compacted uniform bedding materials.
3.2.3 Subgrade Preparation

In order to provide suitable subgrade conditions for the proposed improvements, we recommend the following:

- **Miscellaneous Surface Structures**: The foundations for the various concrete pads and associated pavement should be founded on a minimum of 2 feet of compacted fill. As such, an over-excavation of 3 feet BGS or 2 feet below bottom of foundations, whichever deeper, should be performed. The exposed bottom of excavation should be verified and approved by the geotechnical consultant to confirm suitability. Deeper removal or over-excavation may be required in localized areas depending on prevailing subgrade conditions during construction.

- **Wet Well**: As described in Section 1.1 of this report, the wet well may extend to a depth of approximately 21 feet BGS. As such, the excavation for the wet well may encounter saturated alluvium. If such condition existed during construction, it is then recommended that the subgrade be over-excavated to a depth of 12 inches and replaced with crushed rock or compacted aggregate base (Caltrans Class 2 or similar).

3.2.4 Trench Backfill

Prior to backfilling trenches, pipes should be bedded in and covered with a uniform, granular material that has a Sand Equivalent (SE) of 30 or greater, and a gradation meeting requirements of the pipe manufacturer and EMWD Standards. A minimum cover of 12 inches of bedding material should be provided above the top of the pipe. Pipe bedding should be water-densified in-place. Onsite soils (SM materials) should not be considered for bedding material. However, the SP-SM material may be suitable for this purpose if verified with additional testing during construction.

Native soils (free of deleterious materials such as sludge or others) are generally considered suitable as backfill materials over the pipe bedding zone. Fill materials should be placed in thin lifts moisture conditioned, as necessary, and mechanically compacted to a minimum of 90 percent relative compaction per ASTM D1557 or as required per District standard specifications. The actual lift thickness should depend on the compaction equipment used. If rolling equipment is used for compaction (sheepsfoot, smooth-wheel, segmented wheels, etc.), the fill lift should be a maximum of 8 inches in thickness prior to compaction. For hand-directed mechanical equipment as vibratory plates or tamper, the maximum lift thickness should not exceed 4 inches.
3.2.5 Shrinkage and Subsidence

Change in volume of excavated and recompaacted soil varies according to initial density, which is a function of soil type and location. This volume change is represented as a percentage increase (bulking) or decrease (shrinkage) in volume of fill after removal and recompaaction. Subsidence occurs as natural ground is moisture-conditioned and densified to receive fill. Field and laboratory data used in our calculations included laboratory-measured maximum dry densities for soil types encountered at this site relative to measured, in-place densities of soils sampled. We estimate the following earth volume changes will occur during proper recompaaction:

- **Shrinkage:** Shrinkage due to recompaaction of soils will vary with depth (shrinkage typically decreases with depth). We suggest an estimated shrinkage ranging from 10 to 15 percent in the onsite alluvium.

- **Subsidence:** Subsidence due solely to scarification, moisture conditioning and recompaaction of the exposed bottom of trench over-excavation, is expected to be on the order of 0.1 foot or less. This should be added to the above shrinkage value for the recompaacted fill zone to calculate overall recompaaction lowering of grade.

3.3 Bearing Capacity and Earth Pressures

3.3.1 Bearing Capacity

A net allowable bearing capacity of 2,000 psf, or a modulus of subgrade reaction of 150 pci may be used for design of footings of appurtenant structures founded into a minimum of 2 feet of compacted fill. A minimum base width of 18 inches for continuous footings and a minimum bearing area of 3 square feet (1.75 ft by 1.75 ft) for pad foundations should be used. Additionally, an increase of one-third may be applied when considering short-term live loads (e.g. seismic and wind). Footings should be embedded a minimum of 12 inches below finish grade.

If applicable, lateral loads on thrust blocks and other appurtenant structures may be resisted by passive soil pressure and friction, in combination. An allowable passive pressure based on an equivalent fluid pressure of 300 pounds-per-cubic-foot (pcf), not to exceed 3,000 pounds per square foot (psf) can be used if the pipe is embedded in the alluvium or compacted fill (minimum 2 feet embedment). This equivalent fluid pressure may be doubled for isolated thrust blocks. A soil-pipeline surface friction of 0.20 for PVC pipes.

A modulus of soil reaction (E') of 1,000 psi can be used to estimate the stiffness of the soil bedding backfill at the sides and below buried flexible pipelines for the purpose of evaluating deflection caused by weight of the backfill over the pipe. This value assumes that the proposed pipelines in embedded at 5 to 6 feet below
exiting grades and a granular bedding material with an average relative compaction of 90 percent or more (per ASTM D1557) is placed. An E’ of 1,200 psi can be used where pipeline is underlain by at least 2 feet of compacted soils or crushed rock.

3.3.2 Soils Parameters for Pipeline Design

Structural design of pipes requires proper evaluation of possible loads acting on the pipe, including dead and live or transient loads. Stresses and strains induced in a buried pipe depend on many factors, including the type of pipe, depth and width of trench, bedding and embedment conditions, soil density, angle of internal friction, coefficient of passive earth pressure, and coefficient of friction at the interface between the backfill and in-situ soils. We recommend the following soil parameters for the proposed pipe design:

<table>
<thead>
<tr>
<th>Soil Parameters</th>
<th>Recommended Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average compacted fill moist unit weight, (pcf)</td>
<td>125</td>
</tr>
<tr>
<td>Angle of internal friction of soils (degrees)</td>
<td>33</td>
</tr>
<tr>
<td>Soil cohesion, c (psf)</td>
<td>0</td>
</tr>
<tr>
<td>Sliding friction between pipe and native soils</td>
<td>0.20</td>
</tr>
<tr>
<td>Coefficient of friction between backfill and native soils</td>
<td>0.40</td>
</tr>
</tbody>
</table>

3.3.3 External Loads on Pipe by Soil

Structural design of pipes requires proper evaluation of possible loads acting on the pipe, including dead and live or transient loads. Stresses and strains induced. The magnitude of the load supported depends on the amount of backfill, type of soil, and pipe stiffness. For flexible pipes, the approximate dead load per unit length can be calculated from the following formula:

\[ W = C \gamma B D \]

Where,

- \( W \) = External soil load on pipe: (pounds per foot of pipe)
- \( C \) = Unit less load coefficient  
  (\( C = 1.4 \) for 5 feet deep trench, and 1.8 for 10 feet deep trench, assuming a trench width of 3 feet just above the pipe)
- \( \gamma \) = Total unit weight of soil above pipe (pounds-per-cubic-foot)
- \( B \) = Width of the trench (width just above top of the pipe, in feet)
- \( D \) = Pipe diameter (feet)

In addition to the load from backfill (above equation), loads due to embankments (if applicable) and other loads (live loads) should be considered.
3.4 Retaining Walls Design

Retaining walls can be designed based on a net allowable bearing capacity of 2,000 pounds-per-square-foot (psf), assuming a minimum base width of 18 inches. Additionally, an increase of one-third may be applied when considering short-term live loads (e.g. seismic). Lateral loads may be resisted by friction between the footings and the supporting subgrade. A maximum allowable frictional resistance of 0.45 may be used for design. In addition, lateral resistance may be provided by passive pressures acting against foundations poured neat against properly compacted granular fill. We recommend that an allowable passive pressure based on an equivalent fluid pressure of 300 pounds-per-cubic-foot (pcf) be used in design. Passive pressure should not exceed 3,000 psf. Both friction and passive resistance values may be increased by one-third when considering seismic forces. However, these values should be reduced by a factor-of-safety of 1.5, if used in combination. This passive resistance assumes that the ground is level for at least 7 feet in front of the wall. For properly drained retaining walls, the following parameters may be used to estimate lateral earth pressures:

<table>
<thead>
<tr>
<th>Loading Conditions</th>
<th>Equivalent Fluid Density (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level Backfill</td>
</tr>
<tr>
<td>Active</td>
<td>35</td>
</tr>
<tr>
<td>At-Rest</td>
<td>55</td>
</tr>
</tbody>
</table>

* This assumes level condition in front of the wall will remain for the duration of the project, not to exceed 3,000 psf at depth.

Cantilever walls that are designed to yield at least 0.001H, where H is equal to the wall height, may be designed using the active condition. Rigid walls and walls braced at the top should be designed using the at-rest condition.

Total depth of retained earth for design of walls and for uplift resistance should be measured as the vertical height of the stem below the ground surface at the wall face for stem design, or measured at the heel of the footing for overturning and sliding. A total unit weight of 120 pounds-per-cubic-foot (pcf) may be assumed to calculate weight of compacted fill soil over wall footings, if properly compacted and drained.

In addition to the above lateral forces due to retained earth, surcharge due to above grade loads on the wall backfill, such as traffic, should be considered in design of retaining walls. Vertical surcharge loads behind a retaining wall or in backfill within a 1:1 plane projection up and out from the retaining wall toe, should be considered as lateral and vertical.
surcharge. Unrestrained (cantilever) retaining walls should be designed to resist one-third of these surcharge loads applied as a uniform horizontal pressure on the wall. Braced walls should also be designed to resist an additional uniform horizontal-pressure equivalent to one-half of uniform vertical surcharge-loads. In areas small maintenance vehicle/pickup trucks will drive, we suggest assuming a uniform vertical surcharge of 300 psf, which would result in active and at-rest horizontal surcharges of 100 psf and 150 psf, respectively.

Per 2016 CBC, seismic incremental loads need only to be considered for retaining walls greater than 6-feet in height. An incremental seismic earth pressures of 22H pcf, where H is the retaining wall stem height in feet, may be applied for design in addition to static earth and surcharge pressures presented above. This is based on traditional Mononobe-Okabe equations. Traditionally, this incremental seismic earth pressure has been applied as an inverted triangle (inverted equivalent fluid pressure), with largest dynamic earth pressure occurring at the top of the wall (upper ground surface). Resultant seismic earth pressure force has traditionally been applied at approximately 0.6H from the bottom of the wall, where H is the wall (stem) height. However, recent studies (Sitar, 2013,) suggest that a uniform pressure distribution of 11H psf is likely closer to actual lateral seismic loads and resultant force should be applied at mid-height of wall for level backfill and no shallow groundwater. Sloped backfill should be subject to further evaluation if to be designed for seismic conditions. An incremental seismic earth pressure of 30H pcf may be applied for design of retaining walls with 2:1 backfill slope in addition to the static loads provided in Table above if less than 10 feet in height.

3.5 Wet Well Design Parameters

The design parameters provided in Section 3.4 for typical retaining walls may be used for design of buried structures such as the proposed wet well. However, if the proposed wet well structure is considered braced on top (no yield/movement), then it should be designed using the at-rest earth pressures. Buried structures are typically not subject to additional seismic pressures since they are expected to move or considered part of with the ground during an earthquake event (no fill imbalance between both sides of vault). In addition, the seismic pressures are typically ignored if retaining walls are designed based on at-rest pressures.

For deep footings (greater than 5 feet), the bearing pressure value may be increased by 250 psf for each additional foot of embedment or each additional foot of width to a maximum vertical bearing value of 4,500 psf.
3.6 **Asphalt Paving**

In addition to subgrade preparation recommendations provided in Section 3.2.3, the upper 8 inches of trench backfill and/or pavement areas should be scarified, moisture conditioned to near optimum moisture content and recompacted to a minimum of 95 percent relative compaction prior to placement of aggregate base or asphalt concrete. Aggregate base should also be compacted to 95-percent of the ASTM D1557 laboratory maximum dry density.

Where applicable, pavement patching should at least match existing pavement section or be design based on actual R-value testing and appropriate Traffic Index (TI) selected by the project Civil Engineer. For TI of 6 and based on R-value of 40, a pavement section of 3-inch AC over 6-inch AB will be required per Caltrans Highway Design manual. Asphalt concrete (AC) and aggregate base (AB) should conform to *Caltrans Standard Specifications*, Sections 39 and/or the *Standard Specifications for Public Works Construction* (Green Book, latest Edition).

3.7 **Temporary Cut Slopes**

The contractor is responsible for all temporary slopes and trenches excavated at the site and the design of any required temporary shoring. Shoring, bracing and benching should be performed by the contractor in accordance with the current edition of the *California Construction Safety Orders*, see:

[http://www.dir.ca.gov/title8/sb4a6.html](http://www.dir.ca.gov/title8/sb4a6.html)

During construction, exposed earth material conditions should be regularly evaluated to verify that conditions are as anticipated. The contractor is responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Close coordination between the competent person and geotechnical consultant should be maintained to facilitate construction while providing safe excavations. Existing alluvial soils encountered are classified as OSHA soil Type C. Therefore, unshored temporary cut slopes should be no steeper than 1½:1 (horizontal:vertical), for a height no greater than (≤) 20 feet (*California Construction Safety Orders*, Appendix B to Section 1541.1, Table B-1). These recommended temporary cut slopes assume a level ground surface for a distance equal to one-and-a-half (x1.5) the depth of excavation. For steeper temporary slopes, deeper excavations, and/or where slopes terrain exists within close proximity to excavation (<1.5xdepth), appropriate shoring methods or flatter slopes may be required to protect the
workers in the excavation and adjacent improvements. Such methods should be implemented by the contractor and approved by the geotechnical consultant.

3.8 Temporary Shoring

If the sloped open cut excavation is not feasible based on requirements above and due to existing pavement or structures, excavations for the proposed pipeline should be supported by a temporary shoring system such as cross-braced hydraulic shoring, conventional shields, sheet piles, soldier piles and wood lagging. The choice should be left to the contractor’s judgment since economic considerations and/or the individual contractor’s construction experience may determine which method is more economical and/or appropriate. The contractor and shoring designer should also perform additional geotechnical studies as necessary to refine the means-and-methods of shoring construction.

The support of all adjacent existing structures during excavation and construction (including pavements) without distress is the contractor's responsibility. In addition, it should be the contractor's responsibility to undertake a pre-construction survey with benchmarks and photographs of the adjacent properties. Shoring systems should be designed by a California licensed civil or structural engineer. The design parameters provided in Section 3.4 above may be used for design of temporary shoring.

3.9 Dewatering during Trenching and Pipeline Construction

Based on the results of our exploration, groundwater was encountered at a depth of approximately 21 feet BGS. If encountered during construction (especially during excavation for wet well), groundwater control, such as dewatering, will be required to limit instability of the excavation bottom and sides, and aid foundation construction and soil backfill. Groundwater due to perched saturated conditions can be dewatered utilizing sump-pumps. Dewatering or any other suitable method for stabilizing excavation bottom may be selected by the contractor based on actual groundwater conditions encountered and based on the contractor’s chosen means-and-methods of construction. The selected method by the contractor should be able to effectively mitigate for bottom heave or stabilize subgrade soils during construction/backfilling.

3.10 Corrosivity Testing

Sulfate ions in the soil can lower soil resistivity and can be highly aggressive to Portland cement concrete by combining chemically with certain constituents of the concrete, principally tricalcium aluminate. This reaction is accompanied by expansion and eventual
disruption of the concrete matrix. The sulfate content was determined in the laboratory for representative onsite soil samples. The results indicate that the water-soluble sulfate is considered negligible for this site.

Many factors can affect corrosion potential of soil including soil moisture content, resistivity, permeability and pH, as well as chloride and sulfate concentration. In general, soil resistivity, which is a measure of how easily electrical current flows through soils, is the most influential factor. Based on the findings of studies presented in ASTM STP 1013 titled “Effects of Soil Characteristics on Corrosion” (February 1989), the approximate relationship between soil resistivity and soil corrosiveness was developed as shown in Table below.

Table 4. Relationship between Soil Resistivity and Soil Corrosivity

<table>
<thead>
<tr>
<th>Soil Resistivity (ohm-cm)</th>
<th>Classification of Soil Corrosiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 900</td>
<td>Very Severely Corrosive</td>
</tr>
<tr>
<td>900 to 2,300</td>
<td>Severely Corrosive</td>
</tr>
<tr>
<td>2,300 to 5,000</td>
<td>Moderately Corrosive</td>
</tr>
<tr>
<td>5,000 to 10,000</td>
<td>Mildly Corrosive</td>
</tr>
<tr>
<td>10,000 to &gt;100,000</td>
<td>Very Mildly Corrosive</td>
</tr>
</tbody>
</table>

Acidity is an important factor of soil corrosivity. The lower the pH (the more acidic the environment), the higher the soil corrosivity will be with respect to buried metallic structures and utilities. As soil pH increases above 7 (the neutral value), the soil is increasingly more alkaline and less corrosive to buried steel structures, due to protective surface films, which form on steel in high pH environments. Chloride and sulfate ion concentrations, and pH appear to play secondary roles in affecting corrosion potential. High chloride levels tend to reduce soil resistivity and break down otherwise protective surface deposits, which can result in corrosion of buried steel or reinforced concrete structures.

Table 5. Summary of Corrosivity Testing

<table>
<thead>
<tr>
<th>Location / Boring</th>
<th>Sulfate Content (PPM)</th>
<th>Chloride Content (PPM)</th>
<th>pH</th>
<th>Minimum Resistivity (ohm-cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB-1</td>
<td>86</td>
<td>60</td>
<td>7.83</td>
<td>3,800</td>
</tr>
</tbody>
</table>

Based on the above, the corrosivity characteristics of the onsite soils is considered “moderately corrosive” soils. The test results are included in Appendix A.

Ferrous pipe can be protected by polyethylene bags, tape or coatings, di-electric fittings, concrete encasement or other means to separate the pipe from wet onsite soils. Further
testing of import and possibly site soil corrosivity could be performed and specific recommendations for corrosion protection may need to be provided by a qualified corrosion engineer.

3.11 Additional Geotechnical Services

Recommendations are based on information available at the time our report was prepared and may change as plans are developed, or if supplemental subsurface exploration is authorized. Leighton Consulting, Inc. should review improvements plans, when available, and comment further on geotechnical aspects of the project. Geotechnical observation and testing should be conducted during excavation and all phases of construction. Geotechnical conclusions and preliminary recommendations should be reviewed and verified by us (Leighton Consulting, Inc.) during construction, and revised accordingly if geotechnical conditions encountered vary from our findings and interpretations.
4.0 LIMITATIONS

This report was necessarily based in part upon data obtained from a limited number of observances, site visits, soil samples, tests, analyses, histories of occurrences, spaced subsurface explorations and limited information on historical events and observations. Such information is necessarily incomplete. The nature of many sites is such that differing characteristics can be experienced within small distances and under various climatic conditions. Changes in subsurface conditions can and do occur over time. This exploration was performed with the understanding that the project as described in Section 1.1 of this report.

This report was prepared for Krieger & Stewart, Incorporated based on Krieger & Stewart, Incorporated needs, directions, and requirements at the time of our investigation. This report is not authorized for use by, and is not to be relied upon by any party except Krieger & Stewart, Incorporated, and its successors and assigns as owner of the property, with whom Leighton Consulting, Inc. has contracted for the work. Use of or reliance on this report by any other party is at that party's risk. Unauthorized use of or reliance on this report constitutes an agreement to defend and indemnify Leighton Consulting, Inc. from and against any liability which may arise as a result of such use or reliance, regardless of any fault, negligence, or strict liability of Leighton Consulting, Inc.

The client is referred to Appendix B regarding important information provided by the Geoprosfessional Business Association (GBA) on geotechnical engineering studies and report and their applicability.
REFERENCES


USGS, 2018, an interactive computer program on USGS website to calculate Seismic Response and Design Parameters based on ASCE 7-10 seismic procedures.
BORING LOCATION MAP
EMWD I Lift Station Replacement
Lake Skinner
Temecula Area, California

Project: 12287.001  Eng/Geol: SIS/RFR
Scale: 1"=20'  Date: April 2019
Reference:  Author: MAM

V:\DRAFTING\12287.001\CAD\12287-001_F10_BLM_2019-04-09.DWG (04-09-19 8:45:44AM) Plotted by mmurphy

Legend

LB-1  Approximate Boring Location

Figure 2
APPENDIX A-1

Field Exploration / Log of Exploratory Boring and

Relatively undisturbed soil samples were obtained at selected intervals within the borings using a California ring sampler, with 2.42-inch inside diameter brass rings, driven into the soil with a 140-pound hammer free falling 30-inches in general accordance with ASTM Test Method D3550. The numbers of blows required for each 6 inches of drive penetration were noted in the field and are recorded on the boring logs. Unless otherwise indicated, the blows per foot recorded on the boring logs represent the number of blows required to drive 18 inches in 6-inch increments. In addition, disturbed bag (or bulk) samples were also obtained from soil cuttings. Types of samples obtained from each location are shown on the boring logs at corresponding depths. Our borings were backfilled with soil cuttings obtained during the drilling. Representative earth-material samples obtained from these subsurface explorations were transported to our Temecula geotechnical laboratory for evaluation and appropriate testing.

The attached subsurface exploration logs and related information depict subsurface conditions only at the locations indicated and at the particular date designated on the logs. Subsurface conditions at other locations may differ from conditions occurring at these locations. The passage of time may result in altered subsurface conditions due to environmental changes. In addition, any stratification lines on the logs represent the approximate boundary between soil types and the transition may be gradual.
<table>
<thead>
<tr>
<th>Depth Feet</th>
<th>Graphic Log</th>
<th>Attitudes</th>
<th>Sample No.</th>
<th>Blows Per 6 Inches</th>
<th>Dry Density pcf</th>
<th>Moisture Content %</th>
<th>Soil Class, (U.S.C.S.)</th>
<th>Type of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>N S</td>
<td>B-1</td>
<td></td>
<td>SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1490-</td>
<td></td>
<td>R-1</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>112</td>
<td>SM</td>
<td>SA, SE, MD, CR</td>
</tr>
<tr>
<td>1495-</td>
<td></td>
<td>R-2</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>111</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>1480-</td>
<td></td>
<td>R-3</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>110</td>
<td>SP-SM</td>
<td></td>
</tr>
<tr>
<td>1485-</td>
<td></td>
<td>R-5</td>
<td>9</td>
<td>17</td>
<td>12</td>
<td>116</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>1475-</td>
<td></td>
<td>R-6</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>108</td>
<td>SW</td>
<td></td>
</tr>
<tr>
<td>1470-</td>
<td></td>
<td>R-7</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>108</td>
<td>SM</td>
<td></td>
</tr>
</tbody>
</table>

**SOIL DESCRIPTION**

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

- **@0'**: Quaternary Alluvium (Qal):
  - @0.5': SILTY SAND, loose, dark brown, moist, fine to medium sand, trace clay, some mica (26% fines, SE = 13, MD 134.2 @ 7.0%).
  - @2': Loose, brown, moist, fine to medium sand, some clay and gravel.

- **@5'**: Medium dense, dark olive brown, moist, fine sand, few medium sand.

- **@10'**: Medium dense, brown, moist, fine sand, micaceous.

- **@15'**: Poorly graded SAND with SILT, medium dense, light brown, moist, fine sand, micaceous.

- **@20'**: SILTY SAND, medium dense, dark brown, moist to wet, fine to medium sand, some fine gravel.

- **@25'**: Well-graded SAND, medium dense, light brownish gray, wet, fine to coarse sand with fine gravel, trace silt.

- **@30'**: SILTY SAND, medium dense, dark brown, moist to wet, fine sand, some mica.

Drilled to 30’
Sampled to 31.5’
Groundwater at 20.8’
Backfilled with soil cuttings (3/28/19).

---

**SAMPLE TYPES:**
- BULK SAMPLE
- CORE SAMPLE
- GRAB SAMPLE
- RING SAMPLE
- SPLIT SPOON SAMPLE
- TUBE SAMPLE

**TYPE OF TESTS:**
- -200 % FINES PASSING
- ATTERBERG LIMITS
- CONSOLIDATION
- COLLAPSE
- CORROSION
- UNDRAINED TRIAXIAL
- DIRECT SHEAR
- EXPANSION INDEX
- HYDROMETER
- MAXIMUM DENSITY
- POCKET PENETROMETER
- UNCONFINED COMPRESSIVE STRENGTH
- SIEVE ANALYSIS
- SAND EQUIVALENT
- SPECIFIC GRAVITY

---

*This log is a part of a report by Leighton and should not be used as a stand-alone document.*
APPENDIX A-2

Results of Laboratory Testing
Project Name: EMWD Skinner Lift Station
Project No.: 12287.001

Boring No.: LB-1  Sample No.: B-1
Depth (feet): 0 - 5.0  Soil Type: SM
Soil Identification: Silty Sand (SM), Brown.

GR:SA:FI: (%) 1 : 73 : 26

Leighton

PARTICLE - SIZE DISTRIBUTION
ASTM D 6913

Apr-19
## SAND EQUIVALENT TEST
**ASTM D 2419 / DOT CA Test 217**

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Sample No.</th>
<th>Depth (ft.)</th>
<th>Soil Description</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>R1</th>
<th>R2</th>
<th>SE</th>
<th>Average SE</th>
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</thead>
<tbody>
<tr>
<td>LB-1</td>
<td>B-1</td>
<td>0 - 5.0</td>
<td>Silty Sand (SM)</td>
<td>12:15</td>
<td>12:25</td>
<td>12:27</td>
<td>12:47</td>
<td>12.9</td>
<td>1.5</td>
<td>12</td>
<td>13</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12:17</td>
<td>12:27</td>
<td>12:29</td>
<td>12:49</td>
<td>13.0</td>
<td>1.6</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

**Units:**
- T1 = Starting Time
- T2 = (T1 + 10 min) Begin Agitation
- T3 = Settlement Starting Time
- T4 = (T3 + 20 min) Take Clay Reading (R1)

**Sand Equivalent Calculation:**
Sand Equivalent = \( \frac{R2}{R1} \times 100 \)

- **Record SE as Next Higher Integer**
MODIFIED PROCTOR COMPACTION TEST
ASTM D 1557

Project Name: EMWD Skinner Lift Station
Project No.: 12287.001
Boring No.: LB-1
Sample No.: B-1
Soil Identification: Silty Sand (SM), Dark Brown.

Preparation Method:
- Moist
- Mechanical Ram

Mold Volume (ft³) 0.03340
Ram Weight = 10 lb.; Drop = 18 in.

<table>
<thead>
<tr>
<th>TEST NO.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt. Compacted Soil + Mold (g)</td>
<td>5614</td>
<td>5680</td>
<td>5709</td>
<td>5626</td>
<td></td>
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<tr>
<td>Weight of Mold (g)</td>
<td>3522</td>
<td>3522</td>
<td>3522</td>
<td>3522</td>
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<td></td>
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<tr>
<td>Net Weight of Soil (g)</td>
<td>2092</td>
<td>2158</td>
<td>2187</td>
<td>2104</td>
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<tr>
<td>Wet Weight of Soil + Cont. (g)</td>
<td>612.4</td>
<td>578.3</td>
<td>816.5</td>
<td>932.7</td>
<td></td>
<td></td>
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<tr>
<td>Dry Weight of Soil + Cont. (g)</td>
<td>595.0</td>
<td>556.9</td>
<td>775.9</td>
<td>870.5</td>
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<tr>
<td>Weight of Container (g)</td>
<td>214.7</td>
<td>217.2</td>
<td>312.0</td>
<td>309.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>4.6</td>
<td>6.3</td>
<td>8.8</td>
<td>11.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet Density (pcf)</td>
<td>138.1</td>
<td>142.4</td>
<td>144.4</td>
<td>138.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Density (pcf)</td>
<td>132.0</td>
<td>134.0</td>
<td>132.7</td>
<td>125.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Maximum Dry Density (pcf) 134.2
Optimum Moisture Content (%) 7.0

PROCEDURE USED

- **Procedure A**
  Soil Passing No. 4 (4.75 mm) Sieve
  Mold : 4 in. (101.6 mm) diameter
  Layers : 5 (Five)
  Blows per layer : 25 (twenty-five)
  May be used if +#4 is 20% or less

- **Procedure B**
  Soil Passing 3/8 in. (9.5 mm) Sieve
  Mold : 4 in. (101.6 mm) diameter
  Layers : 5 (Five)
  Blows per layer : 25 (twenty-five)
  Use if +#4 is >20% and +3/8 in. is 20% or less

- **Procedure C**
  Soil Passing 3/4 in. (19.0 mm) Sieve
  Mold : 6 in. (152.4 mm) diameter
  Layers : 5 (Five)
  Blows per layer : 56 (fifty-six)
  Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution: 1:73:26
GR:SA:FI
Atterberg Limits: LL, PL, PI
**SOIL RESISTIVITY TEST**

**DOT CA TEST 643**

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Water Added (ml) (Wa)</th>
<th>Adjusted Moisture Content (MC)</th>
<th>Resistance Reading (ohm)</th>
<th>Soil Resistivity (ohm-cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>10.00</td>
<td>5900</td>
<td>5900</td>
</tr>
<tr>
<td>2</td>
<td>83</td>
<td>16.60</td>
<td>4000</td>
<td>4000</td>
</tr>
<tr>
<td>3</td>
<td>116</td>
<td>23.20</td>
<td>3900</td>
<td>3900</td>
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<tr>
<td>4</td>
<td>149</td>
<td>29.80</td>
<td>4400</td>
<td>4400</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Moisture Content (%) (MCi)**: 0.00
- **Wet Wt. of Soil + Cont. (g)**: 100.00
- **Dry Wt. of Soil + Cont. (g)**: 100.00
- **Wt. of Container (g)**: 0.00
- **Container No.**: A
- **Initial Soil Wt. (g) (Wt)**: 500.00
- **Box Constant**: 1.00
- **MC** = (((1+MCi/100)x(Wa/Wt+1))-1)x100

- **Min. Resistivity (ohm-cm)**: 3800
- **Soil pH**: 7.83
- **Temp. (°C)**: 21.0

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.*
APPENDIX B

GBA Important Information About This Geotechnical Report
The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects
Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared solely for the client. Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled. No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.

Read this Report in Full
Costly problems have occurred because those relying on a geotechnical-engineering report did not read it in its entirety. Do not rely on an executive summary. Do not read selected elements only. Read this report in full.

You Need to Inform Your Geotechnical Engineer about Change
Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:
- The client's goals, objectives, budget, schedule, and risk-management preferences;
- The general nature of the structure involved, its size, configuration, and performance criteria;
- The structure's location and orientation on the site; and
- Other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:
- The site's size or shape;
- The function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- The elevation, configuration, location, orientation, or weight of the proposed structure;
- The composition of the design team; or
- Project ownership.

As a general rule, always inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

This Report May Not Be Reliable
Do not rely on this report if your geotechnical engineer prepared it:
- For a different client;
- For a different project;
- For a different site (that may or may not include all or a portion of the original site); or
- Before important events occurred at the site or adjacent to it, e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. If your geotechnical engineer has not indicated an “apply-by” date on the report, ask what it should be, and, in general, if you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the “Findings” Related in This Report Are Professional Opinions
Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.
This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations only after observing actual subsurface conditions revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

• confer with other design-team members,
• help develop specifications,
• review pertinent elements of other design professionals’ plans and specifications, and
• be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, but be certain to note conspicuously that you’ve included the material for informational purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, only from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and be sure to allow enough time to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured Unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated subsurface environmental problems have led to project failures. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer’s services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. Geotechnical engineers are not building-envelope or mold specialists.
APPENDIX D

RECORD DRAWINGS
LIFT STATION DRAWINGS
NOTE: VERIFY LOCATION AND DEPTH OF ALL ELECTRICAL CONDUITS.

**Notes:**

1. **All equipment shall be new unless noted otherwise.**

2. **New conduits (H.H.) shall be BROWSEL.**
   - Half & cover marked "electrical."

3. **New pull boxes (P.B.) shall be HYPERKET #1 PB 100**
   - 1/4 PE 1000 cover.

4. **Electrical Contract for coordination with plumbing.**
   - Conduit for trenching between PB #2 and launch ramp 2 and DIVOC. costs accordingly.

5. **Exist "mini power zone." Panel P-11 shall be removed from exist. loc. & reinstall on the inside of prefabricated restroom.**

6. **High water alarm shall be mounted on the light pole.**
EXISTING IRRIGATION TO REMAIN. DURING COURSE OF CONSTRUCTION; CONTRACTOR TO ADJUST EXISTING HEAD(S) AS NEEDED IN-FIELD SO AS TO PROVIDE COVERAGE BUT TO AVOID OVERSPRAY IN AREA OF IMPROVEMENTS. SEE ALSO IRRIGATION PLANS.

EXISTING IRRIGATION TO REMAIN; PROTECT IN PLACE, TYPICAL VALVE 58-TREE, VALVE 55-SHRUB.

EXISTING IRRIGATION HEADS ADJACENT TO IMPROVEMENTS: IRRIGATION TO REMAIN. IF NECESSARY DURING COURSE OF CONSTRUCTION; CONTRACTOR TO ADJUST HEADS AND LATERALS TO PREVENT DAMAGE OR OVERSPRAY (VALVE 70).

EXISTING HARDSCAPE TO BE REPLACED FOR 'TEXT'; SEE LC-2.2 AND CIVIL PLANS.

EXISTING MAINLINE & VALVES FOR REFERENCE, TYPICAL. PROTECT IN PLACE.

CLEAR & GRUB EXISTING TURF AREA. REMOVE EXISTING IRRIGATION HEADS AND LATERALS AS NOTED ON PLAN. REFER TO CIVIL PLAN FOR ADDITIONAL DEMOLITION NOTES.

REMOVE EXISTING RESIDENTIAL TURF AND BASE COURSE.

SHOVEL CUT EXISTING TURF. REFER ALSO TO GRADING PLANS FOR DAYLIGHT LINE, SHEETS C-1.1 THROUGH C-1.3.

EXISTING TREE TO BE REMOVED.

EXISTING RESIDENTIAL TURF AND BASE COURSE.

EXISTING HARDSCAPE TO BE REPLACED FOR "TEXT". REFER TO CIVIL PLANS.

EXISTING HARDSCAPE, TYPICAL. PROTECT IN PLACE.

REVIEW BOTH ELECTRICAL AND SPLASH PAD PLANS FOR TRENCHING LOCATIONS.

PATCH & REPAIR EXISTING TURF AREA. SLEEVE CONDUIT UNDER HARDSCAPE, TYPICAL. PROTECT EXISTING IRRIGATION AND TREES IN PLACE, TYPICAL.

SAWCUT; AS NOTED PER PLAN OR PANEL TO PANEL / JOINT TO JOINT, TYPICAL. VERIFY IN-FIELD WITH LANDSCAPE ARCHITECT PRIOR TO CONSTRUCTION.

SHOVEL CUT EXITING TURF; SEE ALSO CIVIL PLAN.
**EXISTING**

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<th>Circuit Type</th>
<th>Comments</th>
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**LOAD SUMMARY - MSB**

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**SINGLE LINE DIAGRAM**

**KEY NOTES**

1. **EXISTING**:
   - Panel E1
   - Panel E2
   - Panel E3
   - Panel E4
   - Panel E5
   - Panel E6
   - Panel E7
   - Panel E8
   - Panel E9
   - Panel E10

2. **EXISTING**:
   - Panel MSB

3. **BID ALTERNATE #3**
   - Panel E1
   - Panel E2
   - Panel E3
   - Panel E4
   - Panel E5
   - Panel E6
   - Panel E7
   - Panel E8
   - Panel E9
   - Panel E10

4. **BID ALTERNATE #3**
   - Panel MSB

---

**37701 Warren Road**

Winchester, CA  92596

---

**811 TRENCH WARNING**

Call before you dig.

---

**Drawing Information**

- **SDG PRO NO:** 15-409
- **Drawing Date:** 06/03/2016
- **Drawn By:** NJA / PS
- **Checked By:** NJA
- **Sheet No:** 65

---

**LAKE SKINNER SPLASH PAD EXPANSION**

06/03/2016 - 100% Construction Documents
APPENDIX E

PUMP CONTROL PANEL DIAGRAMS
NOTE: ALL PILOT LIGHTS TO BE LED AND PUSH-TO-TEST, 30 MM, OIL-TIGHT
APPENDIX F

FLYGT PRE-NEGOTIATED EQUIPMENT PROPOSAL
Xylem Water Solutions USA, Inc.  
Flygt Products  
11161 Harrel Street  
Mira Loma, CA 91752  
Tel (951) 332-3668  
Fax (951) 332-3679

August 18, 2020  
EASTERN MUNICIPAL WATER DSTRCT  
PO BOX 8300  
PERRIS CA 92572

Quote # 2019-LAB-0229 Alternate 1, Version 2  
Project Name: EMWD Lake Skinner No. 1

Xylem Water Solutions USA, Inc. is pleased to provide a firm quote for the following Flygt equipment valid through March 31, 2021.

### Pumps

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<th>Part Number</th>
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<td>3069.070-0006</td>
<td>Flygt Model NX-3069.070 2.5&quot; volute Submersible pump equipped with a 460 Volt / 3 phase / 60 Hz 2.7 HP 3550 RPM motor, 275 impeller 50 Ft. length of SUBCAB 4G2,5+2x1,5 submersible cable, FLS leakage detector</td>
</tr>
<tr>
<td>3</td>
<td>14-69 00 09A</td>
<td>START UP,FLYGT,NO TAX 1-DAY</td>
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<tr>
<td>2</td>
<td>83 57 24</td>
<td>GRIP,CABLE SS 19-24MM</td>
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<tr>
<td>2</td>
<td>14-58 75 60</td>
<td>CABLE,LIFTING ASSY 1/4&quot;X20'+ 316</td>
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<tr>
<td>2</td>
<td>748 18 10</td>
<td>KIT,SLIDING BRACKET DN80 ENF+ CI FOR 3&quot; DISCHARGE 2&quot;GB GREY</td>
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<tr>
<td>2</td>
<td>14-69 95 12</td>
<td>TEST FACTORY 2.2 PLOTTED 3045-3127 FAL 15-900006</td>
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<td>2</td>
<td>14-69 95 72</td>
<td>TEST FACTORY 2.8 VIBRATN 3045-3127 FAL 15-900015</td>
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**Pumps Price USD** $13,156.20

### Pre-Engineered Valve Vault

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<td>VV 6X5.5-4SS</td>
<td>Flygt Pre-Engineered Fiberglass Valve Vault, 6&quot; diameter, 5'-6&quot; depth, 4&quot; Sched 40 SS piping, 12&quot; plain end fittings outside of vault (2) 4&quot; &amp; (1) 6&quot; Dresser coupling for connection to wet well piping &amp; discharge pipe. SS Pipe supports. Aluminum cover - 1/4&quot; thick, pedestrian loading rated with integral SafeHatch access cover with slam lock and recessed padlock. Shop drawings (preliminary and revised as-built)</td>
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<tr>
<td></td>
<td></td>
<td>- Dezurik plugs</td>
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<td>- ARI D020 SS air release valve</td>
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<td>- Mueller swing check valves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 4&quot; Tideflex checkmate duckbill valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 4&quot; 316SS Victaulic coupling as per Dwg M-1</td>
</tr>
</tbody>
</table>

**Basic Price DOES NOT include:**
- Site excavation, preparation and back filling.
- Unit unloading at jobsite.
- Unit or piping installation.
- Valve Vault drainage line.
- Ladder.
- Flow meters.
- Pressure gauges.

**Pre-Engineered Valve Vault Price USD** $32,655.49
Pre-Engineered Station

<table>
<thead>
<tr>
<th>Qty</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1   | TOP6X24-4SS | Flygt Pre-Engineered Fiberglass Pump Station, 6' dia. x 24' depth, self-cleaning bottom, anti-flotation flange, exterior UV protection coating on top 24", 3" CI discharge base elbow, 4" SS Sch40 discharge piping FRP filament wound shell section joined to TOPS basin Sanitary white corrosion liner, 110 mil thick Aluminum top c/w Safe-Hatch 300 psf rated bolted and sealed to shell flange One Level Regulator hanger bolted to access hatch Two anti-sway rings bolted to the side of the tank 316 Stainless Steel guide rails Flygt SS guide rail brackets upper and intermediate as needed Level probe hangers 1 FRP inlet up to 8" pipe inlet Green gelcoat on top 2' of shell for UV protection All bolting penetrations through shell to be laminated over All piping projections to be 7" in length 2" drain connection from vault c/w PVC flapper check valve when applicable Bulkhead style PVC electrical connections 1-3" & 1-1.25" Shipping saddles banded to tank Shop drawings (preliminary and revised as-built)

Basic Price DOES NOT include:
- Site excavation, preparation or back-filling.
- Unit unloading at jobsite.
- Unit or piping installation.
- Purchase and/or placing of anti-flotation ballast.
- Additional inlet sealing hubs or hubs for pipes greater than 8" diameter.

5  14-69 00 09A  START UP,FLYGT,NO TAX  1-DAY

Pre-Engineered Station Price USD $ 56,557.55
**Duplex Control Panel**

<table>
<thead>
<tr>
<th>Qty</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CNTRLPNLDPLX</td>
<td>Duplex alternating control panel - Components Include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. NEMA 4X 316 Stainless Steel Enclosure with 3 Pt. Pad-Lockable Handle and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Door Stops.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Aluminum Inner Door.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Power Distribution Blocks or Lugs as Required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Neutral and Ground Lugs as Required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9. Fused 7.5KVA Dry Type Transformer, Outer Enclosure Mounted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10. A-B Control and Accessory Circuit Breakers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11. 15A GFCI, Inner Door Mounted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12. 24VDC Power Supply.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13. Milltronics Controller, Inner Door Mounted: w/Ultrasonic Transducer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14. Mini-Cas SF/HT Modules Installed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15. Solid State Alternator with Integral Lead Select Switch.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16. 30mm PTT LED Pilot Lights and Non-Illuminated Switches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17. Elapsed Time Meter Each Pump.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20. Seal Fail Pilot Light Each Pump.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23. Terminals for Submersible Transmitter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25. Dry Contacts. (Run, No Run, In Auto, In Hand, SF, HT, Common)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26. UL508A Listed.</td>
</tr>
</tbody>
</table>

**Notes:**
- Installation, Junction Boxes, Disconnects, Meter Sockets and Bases, ATS, G.R., Hubs, Conduit, and Any Other External Items by Others.
- Other Items Not Specifically Stated Above are Not Included.

<table>
<thead>
<tr>
<th>Qty</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>582 88 04</td>
<td>SENSOR,ENM-10 0.95-1.1 65'</td>
</tr>
<tr>
<td>1</td>
<td>14-69 00 09A</td>
<td>START UP,FLYGT,NO TAX 1-DAY</td>
</tr>
</tbody>
</table>

**Duplex Control Panel Price USD**  $27,465.46

<table>
<thead>
<tr>
<th>Qty</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>82 40 61</td>
<td>WASHER,SS 24.5MM ID 35MM OD</td>
</tr>
<tr>
<td>4</td>
<td>84 37 98</td>
<td>GROMMET,NBR 18.5ID 35OD 24L</td>
</tr>
<tr>
<td>4</td>
<td>678 58 18</td>
<td>CLIP,CABLE PLASTIC</td>
</tr>
<tr>
<td>2</td>
<td>801 01 01</td>
<td>KIT,REPAIR BASIC 3069</td>
</tr>
</tbody>
</table>

**Spare Parts Price USD**  $1,395.30
Bond

<table>
<thead>
<tr>
<th>Qty</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maintenance Bond is required in Section 11073 pump section</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost is included</td>
</tr>
</tbody>
</table>

Total Price $ 131,229.99
Freight Charge $ 1,557.36
Total Price $ 132,787.35

Exceptions:
- Plumbing the air release from the VV to the WW plumbing will stop outside the wall
- Plumbing the drain from the VV to the WW plumbing will stop outside the bottom of the VV base

Terms & Conditions
This order is subject to the Standard Terms and Conditions of Sale – Xylem Americas effective on the date the order is accepted which terms are available at [http://www.xyleminc.com/en-us/Pages/terms-conditions-of-sale.aspx](http://www.xyleminc.com/en-us/Pages/terms-conditions-of-sale.aspx) and incorporated herein by reference and made a part of the agreement between the parties.

Purchase Orders: Please make purchase orders out to: Xylem Water Solutions USA, Inc.
Freight Terms: 3 DAP - Delivered At Place 08 - Jobsite (per IncoTerms 2020)

Taxes: State, local and other applicable taxes are not included in this quotation.

Back Charges: Buyer shall not make purchases nor shall Buyer incur any labor that would result in a back charge to Seller without prior written consent of an authorized employee of Seller.

Shortages: Xylem will not be responsible for apparent shipment shortages or damages incurred in shipment that are not reported within two weeks from delivery to the jobsite. Damages should be noted on the receiving slip and the truck driver advised of the damages. Please contact our office as soon as possible to report damages or shortages so that replacement items can be shipped and the appropriate claims made.

Taxes: State, local and other applicable taxes are not included in this quotation.

Terms of Delivery: PP/Add Order Position
Time of Delivery: Approximately 10 working weeks after approval of order and receipt of approved submittal.

Validity: This Quote is valid for ninety (90) days.

Terms of Payment: 90% N30 after invoice date; 10% NTE 90 days after initial invoice date.
Xylem’s payment shall not be dependent upon Purchaser being paid by any third party unless Owner denies payment due to reasons solely attributable to items related to the equipment being provided by FLYGT.

Changes: This Quote is based on the current design criteria provided to Xylem Water Solutions USA, Inc. Revisions may result in price changes.

Exclusions: This Quote includes only the items listed specified above.
**Delivery Information:**
ALL STRUCTURES WILL BE DELIVERED ON FLATBED TRUCKS, TO BE OFF LOADED BY OTHERS.
HEAVIEST STRUCTURE TO WEIGH APPROX 3,000 LBS.
Delivery will be on weekdays during normal business hours, excluding holidays.
Xylem Water Solutions USA, Inc. has allowed one (1) hour free time per station at destination point for unloading. After expiration of free time Xylem Water Solutions USA, Inc. shall be entitled to demurrage costs.

**Exclusions:** Unless specifically stated above, this Quote does not include:
- Liquid inside the pump station for pump and system Start Up
- Incoming power and meter socket
- Excavation, backfilling, and compaction
- Permits
- Mounting of the control panel
- Conduit and wiring between the control panel and pump station
- Site installation and wiring

**Storage:** Any major component, pump station, valve vault, pumps or controls not delivered within thirty (30) days of the completion of manufacturing may be subject to storage charges, including shipping and handling charges if goods must be transported to a secondary storage facility.

**Start Up:** Start Up/Owner Training per spec is included.

**Changes:** This Quote is based on the design criteria provided to Xylem Water Solutions USA, Inc. Revisions may result in price and/or delivery changes.

**Installation:** All excavation and backfilling must be done in accordance with installation guidelines as outlined in Installation, Care and Maintenance Manual.
Contractor is responsible for cast in place concrete to be used with anti-flotation collar.

Sincerely,

Alan Dahlqvist
Direct Sales Representative
Phone: 951/332-3669
Cell: 951/553-1493
alan.dahlqvist@xyleminc.com
Fax: 951/332-3679
APPENDIX G

SHUTDOWN COORDINATION SCHEDULE
**SHUTDOWN COORDINATION SCHEDULE**

<table>
<thead>
<tr>
<th>No.</th>
<th>Shutdown</th>
<th>Purpose</th>
<th>Notice Requirements</th>
<th>Maximum Duration (2)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Panelboard LA</td>
<td>Install new circuit breakers and connect new conductors</td>
<td>X X X X</td>
<td>2 hours</td>
<td>See Note (3)</td>
</tr>
<tr>
<td>2</td>
<td>Skinner 1 Lift Station</td>
<td>Connect new standby power generation system conductors to existing lift station power feed conductors</td>
<td>X X X X</td>
<td>2 Hours</td>
<td>See Note (4)</td>
</tr>
<tr>
<td>3</td>
<td>Skinner 4 Lift Station</td>
<td>Connect new standby power generation system conductors to existing lift station power feed conductors</td>
<td>X X X X</td>
<td>2 Hours</td>
<td>See Note (3)</td>
</tr>
<tr>
<td>4</td>
<td>Skinner 1 Lift Station</td>
<td>Connection of new lift station discharge piping to existing force main piping</td>
<td>X X X X</td>
<td>6 Hours</td>
<td>See Note (4)</td>
</tr>
<tr>
<td>5</td>
<td>Skinner 1 Lift Station</td>
<td>Connect new lift station temporary power feed conductors to existing lift station disconnect switch</td>
<td>X X X X</td>
<td>1 Hour</td>
<td>See Note (3)</td>
</tr>
<tr>
<td>6</td>
<td>Skinner 1 Lift Station</td>
<td>Connect new lift station permanent power feed conductors to existing lift station power feed conductors and disconnect existing lift station discharge piping</td>
<td>X X X X</td>
<td>6 Hours</td>
<td>See Note (4)</td>
</tr>
</tbody>
</table>

**Notes:**

1. See Special Conditions and Section 01185 for additional shutdown coordination and construction sequencing requirements.
2. Contractor shall work continuously and diligently during the shutdown period to limit the total duration of the shutdown event. Contractor shall not stop work or demobilize during the shutdown event.
3. Shutdown is only allowed between 10:00 a.m. and noon (Tuesday or Wednesday).
4. Shutdown is only allowed between 9:00 a.m. and 3:00 p.m. (Tuesday, Wednesday, or Thursday).
APPENDIX H

ASBESTOS SURVEY REPORT
[PAGE LEFT INTENTIONALLY BLANK]
Asbestos Survey Report
EMWD – Skinner 1 Lift Station

Eastern Municipal Water District
Skinner 1 Lift Station
37950 Warren Road
Winchester, California 92596

Prepared for:
Patrick Sweeney, Principal
CSI Services, Inc.
P. O. Box 801357
Santa Clarita, CA 91380
661-478-8900 | psweeney@CSIServices.biz

Prepared by:
Ms. Julie Zak, Project Manager
Forensic Analytical Consulting Services
7625 Sunrise Boulevard, Suite 104
Citrus Heights, CA 95610
916-726-1303 | jzak@forensicanalytical.com

FACS Project: PJ45534
## Contents

Executive Summary .......................................... 1  
Introduction ................................................... 2  
Scope of Work .................................................. 2  
Site Characterization ....................................... 2  
Survey Methods ................................................ 3  
Findings and Recommendations ....................... 5  
Limitations ..................................................... 6  

Appendix A  Asbestos Inspection Documents  
Attachment I  Material Classifications  
Attachment II  Sample Location Drawings  
Attachment III  Asbestos Results Table  
Attachment IV  Laboratory Report and Chain of Custody

Appendix B  Representative Photographs

Appendix C  Certifications of Personnel
# List of Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCM</td>
<td>Asbestos Containing Construction Material</td>
</tr>
<tr>
<td>ACM</td>
<td>Asbestos Containing Material</td>
</tr>
<tr>
<td>AHERA</td>
<td>Asbestos Hazard Emergency Response Act</td>
</tr>
<tr>
<td>AIHA</td>
<td>American Industrial Hygiene Administration</td>
</tr>
<tr>
<td>APCD</td>
<td>Air Pollution Control District</td>
</tr>
<tr>
<td>AQMD</td>
<td>Air Quality Management District</td>
</tr>
<tr>
<td>CAC</td>
<td>Certified Asbestos Consultant</td>
</tr>
<tr>
<td>Cal/OSHA</td>
<td>California Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>CARB</td>
<td>California Air Resources Board</td>
</tr>
<tr>
<td>CCR</td>
<td>California Code of Regulations</td>
</tr>
<tr>
<td>CDPH</td>
<td>California Department of Public Health</td>
</tr>
<tr>
<td>Cal/EPA</td>
<td>California Environmental Protection Agency</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>CSLB</td>
<td>California Contractor Licensing Board</td>
</tr>
<tr>
<td>CSST</td>
<td>Certified Site Surveillance Technician</td>
</tr>
<tr>
<td>DOSH</td>
<td>Department of Occupational Safety and Health</td>
</tr>
<tr>
<td>DTSC</td>
<td>Department of Toxic Substances Control</td>
</tr>
<tr>
<td>ELAP</td>
<td>Environmental Laboratory Accreditation Program</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>FACS</td>
<td>Forensic Analytical Consulting Services, Inc.</td>
</tr>
<tr>
<td>Flame AAS</td>
<td>Flame Atomic Absorption Spectroscopy</td>
</tr>
<tr>
<td>Federal/OSHA</td>
<td>Federal Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>HUD</td>
<td>Housing and Urban Development</td>
</tr>
<tr>
<td>NESHAP</td>
<td>National Emissions Standard for Hazardous Air Pollutants</td>
</tr>
<tr>
<td>NIOSH</td>
<td>National Institute for Occupational Safety and Health</td>
</tr>
<tr>
<td>NIST</td>
<td>National Institute of Science and Technology</td>
</tr>
<tr>
<td>NVLAP</td>
<td>National Voluntary Laboratory Accreditation Program</td>
</tr>
<tr>
<td>PLM</td>
<td>Polarized Light Microscopy</td>
</tr>
<tr>
<td>SCAQMD</td>
<td>South Coast Air Quality Management District</td>
</tr>
<tr>
<td>SGS-FL</td>
<td>SGS Forensic Laboratories</td>
</tr>
<tr>
<td>TEM</td>
<td>Transmission Electron Microscopy</td>
</tr>
<tr>
<td>TTLC</td>
<td>Total Threshold Limit Concentration</td>
</tr>
</tbody>
</table>
Executive Summary

Forensic Analytical Consulting Services, Inc. (FACS) was retained by CSI Services, Inc. (CSI) to perform an asbestos survey at the Skinner 1 Lift Station site in support of the Eastern Municipal Water District (EMWD) pump replacement and renovation project located at 37950 Warren Road in Winchester, California. The survey was limited to suspect asbestos-containing material (ACM) that will be disturbed during the renovation project. The survey was performed on February 27, 2020.

Asbestos

The following materials were identified as asbestos-containing materials:

No materials were identified as, or assumed to be, asbestos-containing during this survey.

The asbestos survey information provided in Appendix A has been formatted to meet the reporting requirements of the Federal National Emissions Standard for Hazardous Air Pollutants (NESHAP) and the South Coast Air Quality Management District (SCAQMD) Rule 1403.

Any suspect materials not included in this inspection must be assumed to be ACM until such time as they are tested and proven not to contain asbestos.

FACS recommends that the results of this report be incorporated into any renovation/demolition plans for this structure.
Introduction

Forensic Analytical Consulting Services, Inc. (FACS) was retained by CSI Services, Inc. (CSI) to perform an asbestos survey at the Skinner 1 Lift Station site in support of the Eastern Municipal Water District (EMWD) pump replacement and renovation project located at 37950 Warren Road in Winchester, California. The survey was limited to suspect asbestos-containing material (ACM) that will be disturbed during the renovation project. The survey was performed on February 27, 2020.

All FACS personnel conducting asbestos inspections are accredited Environmental Protection Agency (EPA), Asbestos Hazard Emergency Response Act (AHERA) – 40 CFR Part 763 Building Inspectors and State of California, Department of Industrial Relations, Division of Occupational Safety and Health (Cal/OSHA), Certified Asbestos Consultant (CAC) or a Certified Site Surveillance Technician (CSST) working under the direction of a CAC.

• Appendix A – Asbestos Results
• The asbestos survey information provided in Appendix A has been formatted to meet the reporting requirements of the Federal National Emissions Standard for Hazardous Air Pollutants (NESHAP) as enforced by South Coast Air Quality Management District (SCAQMD) Rule 1403.
• Appendix B – Representative Photographs
• Appendix C – Certifications of Personnel

Scope of Work

The purpose of this survey was to identify all ACMs that will be disturbed as part of the EMWD Skinner 1 Lift Station pump replacement and renovation project. The visual inspection, bulk sampling and survey documentation was performed by Oleksandr Zhdanyuk, CAC #19-6476, as required by regulations. The scope of the survey and the services provided by FACS included:

• Performing a visual inspection of the building to identify accessible suspect ACM that may be disturbed during the planned renovation project;
• Collection of bulk samples of suspect ACM for asbestos content analysis by Polarized Light Microscopy (PLM) using the EPA Method 600/R-93/116;
• Ensuring the technical quality of all work by using EPA–AHERA-accredited Building Inspectors and Management Planner-accredited personnel;
• Consolidating data and findings into a report format.

Site Characterization

The Skinner 1 Lift Station is a freestanding CMU building which houses pumping systems with a variety of related equipment on the interior and exterior of the structure. The facility is located in a residential area with concrete and asphalt grounds surrounded by a CMU brick wall separating the facility from adjacent structures. The facility houses three primary pumps / pipelines / valves bolted in place on raised footings. Standard metal and roll up doors provide access to the interior. The site is not accessible to the general public and required EMWD personnel to provide access to through locked gates and doors.
The suspect building materials identified that will, or may be disturbed during the planned renovation, included:

- Gray concrete (wet well walls, manhole access, dry well)
- Blue paint with red prime coat
- Green paint
- Red paint
- Gray and beige paint
- Gray paint
- Black coating
- Gray caulking
- Gray concrete (electrical room)
- CMU mortar (electrical room)

**Survey Methods**

**Visual Inspection**

Accessible building materials were visually inspected using the methods presented in the federal AHERA regulations [40 Code of Federal Regulations (CFR), Part 763] and federal HUD guidelines. While AHERA is only directly applicable to public schools and the HUD guidelines are only directly applicable to public housing, the principles presented under the above referenced rules are generally accepted as the industry standard for ACM inspections.

No spaces were inaccessible during this inspection.

**Asbestos Inspection**

Accessible building materials were inspected using the methods presented in the federal AHERA regulations [40 Code of Federal Regulations (CFR), Part 763] as a guideline. Suspect ACMs were physically assessed for friability, condition and possible disturbance factors.

**Bulk Sample Collection**

Bulk samples of identified homogeneous areas were collected in building areas that may be impacted by the planned renovation/demolition activities. Samples were collected of each separate homogeneous area. A homogeneous area is defined as a surfacing material, thermal system insulation, or miscellaneous material that is uniform in use, color and texture. Examples of homogeneous areas could include:

- Floor tile
- Ceiling tile
- Gypsum wallboard and joint tape compound
- Linoleum
The specific number of samples collected was primarily determined by using the methods presented in the federal AHERA regulations (40 CFR, Part 763.86):

- For Surfacing Material:
  - 1,000 square feet (ft²) or less - collect 3 samples
  - 1,001 to 5,000 ft² - collect 5 samples
  - 5,001 ft² or greater - collect 7 samples
- For Thermal System Insulation:
  - "In a randomly distributed manner" - collect 3 samples
  - 6 linear feet of patching or less - collect 1 sample
  - cementitious pipe fittings - "In a manner sufficient to determine"
- For all Miscellaneous Material:
  Collect samples "In a manner sufficient to determine whether material is ACM or not ACM..."

The suspect ACMs were sampled using a knife or other similar coring device suitable to the type of material sampled to cut through its entire thickness and to ensure that a cross-section of the material was obtained. The material was then placed in an appropriately labeled container that was sealed and submitted to SGS Forensic Laboratories, Inc. for analysis. A unique sample number (e.g. DS-101-01) was assigned to each sample.

Bulk samples will be retained by the laboratory for one month unless otherwise instructed. After this period, the samples will be disposed of appropriately.

**Bulk Sample Analysis**

A total of twenty-six (26) bulk samples were collected. Bulk samples were analyzed by SGS Forensic Laboratories, Inc. (SGS-FL) in Hayward, CA. SGS-FL is accredited by the California Department of Public Health (CDPH) and the National Institute of Science and Technology's (NIST) National Voluntary Laboratory Accreditation Program (NVLAP). SGS-FL participates in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing Program and has substantial experience in the analysis of asbestos. All of the samples were analyzed using Polarized Light Microscopy with Dispersion Staining (PLM/DS) techniques in accordance with the methodology approved by the U.S. EPA. The percentage of asbestos present in the samples was determined on the basis of visual area estimation. The EPA defines ACM as any material containing more than one percent (1%) asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR Part 763, Section 1, Polarized Light Microscopy (PLM). 40 CFR Part 763 identifies the lower limit of reliable quantification for asbestos using the PLM method as approximately one percent (1%) by volume.

Regulations in California [Cal/OSHA Title 8 California Code of Regulations (CCR) 1529] define asbestos-containing construction materials (ACCM) as those materials having asbestos content of greater than one tenth of one percent (> 0.1%). Therefore, for the purpose of this survey, any amount of asbestos detected will be considered positive. In addition to the percentages, the types of asbestos minerals are also reported. The PLM method is the standard method used to analyze asbestos bulk samples.

When "None Detected" (ND) appears in the laboratory results, it should be interpreted as meaning no asbestos was observed in the sample material.
Discussion

Materials for which sample analysis by PLM results are greater than one percent asbestos (for any one sample collected from a homogeneous material) are classified as an asbestos-containing material (ACM) under regulations promulgated by (but not limited to) the following agencies: National Emissions Standard for Hazardous Air Pollutants (NESHAP), South Coast Air Quality Management District (SCAQMD) and Cal/OSHA.

Materials for which sample analysis by PLM (Point Count) are less than one percent asbestos (for all samples collected from a homogeneous material) are classified as asbestos-containing construction material (ACCM) under Cal/OSHA and California Contractor Licensing Board (CSLB).

The agencies use the following definitions:

- **NESHAP**: Materials containing greater than one percent asbestos are ACM
- **SCAQMD**: Materials containing greater than one percent asbestos are ACM
- **Cal/OSHA**: Materials containing greater than 0.1% asbestos by weight are ACCM
- **CSLB**: Materials containing greater than 0.1% asbestos by weight are ACCM

Materials shown in the table as containing asbestos are regulated materials under the EPA and SCAQMD regulations, Cal/OSHA regulations, and other regulatory agencies.

SCAQMD Rule 1403 requires (with limited exceptions) that both friable and non-friable ACM in buildings be removed prior to maintenance, repairs, renovation or demolition that would disturb the material. Work involving the disturbance of ACM also requires ten working days prior notification to SCAQMD (exemption for less than 100 square feet) and notification to Cal/OSHA.

Findings and Recommendations

FACS conducted an asbestos inspection survey in support of the EMWD Skinner 1 Lift Station pump replacement and renovation project located at 37950 Warren Road in Winchester, California for the presence of ACMs that will be impacted by the proposed renovation project.

Asbestos

The following materials were identified as ACMs during the survey:

**No materials were identified as, or assumed to be, asbestos-containing during this survey.**

Major renovations and/or demolition of the structures involved in this inspection must be permitted and conducted in compliance with Federal NESHAP, as enforced by the SCAQMD RULE 1403.

Any suspect materials not included in this inspection must be assumed to be an ACM until such time as they are tested and proven not to contain asbestos.
Limitations

This investigation is limited to the conditions and practices observed and information made available to FACS. The methods, conclusions and recommendations provided are based on FACS’ judgment, expertise and the standard of practice for professional service. They are subject to the limitations and variability inherent in the methodology employed. As with all environmental investigations, this investigation is limited to the defined scope and does not purport to set forth all hazards, nor indicate that other hazards do not exist.

Please do not hesitate to contact our offices at 916-726-1303 with any questions or concerns. Thank you for the opportunity to assist CSI Services, Inc promoting a more healthful environment.

Respectfully,

FORENSIC ANALYTICAL

Reviewed by:

FORENSIC ANALYTICAL

Julie Zak
Certified Site Surveillance Technician No. 12-4887
Project Manager

James Rich
Certified Asbestos Consultant No. 96-2035
Senior Project Manager
Appendix A

Asbestos Inspection Documents
Appendix A

Attachment I

Material Classifications

Asbestos

No materials were identified as, or assumed to be, asbestos-containing during this survey.

The following **FRIABLE ASBESTOS-CONTAINING MATERIAL** are materials containing more than one percent (1%) asbestos that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure, which are present in the structure must be removed prior to demolition.

- None

The following **CLASS I NONFRIABLE ASBESTOS-CONTAINING MATERIAL** is material containing more than one percent (1%) asbestos, and that, when dry, can be broken, crumbled, pulverized, or reduced to powder in the course of demolition or renovation activities. Actions which may cause material to be broken, crumbled, pulverized, or reduced to powder include physical wear and disturbance by mechanical force, such as, but not limited to, sanding, sandblasting, cutting or abrading, improper handling or removal or leaching of matrix binders. Class I nonfriable asbestos-containing material includes, but is not limited to, fractured or crushed asbestos cement products, transite materials, mastic, roofing felts, roofing tiles, cement water pipes and resilient floor covering. The following materials are present in the structure.

- None

The following **CLASS II NONFRIABLE ASBESTOS-CONTAINING MATERIAL** is all other material containing more than one percent (1%) asbestos, that is neither friable asbestos-containing material or Class I nonfriable asbestos containing material. The following materials are present in the structure.

- None

Major renovations and/or demolition of the structures involved in this inspection must be permitted and conducted in compliance with Federal NESHAP and SCAQMD RULE 1403.

Any suspect material not included in this inspection must be assumed to be an asbestos-containing material until such time as it is tested and proven not to contain asbestos.
Appendix A

Attachment II

Sample Location Drawings
Asbestos Sample Location Map
Skinner I Lift Station - Electrical Room

CLIENT: CSI Services, Inc.  DATE: 02/27/2020
PROJECT: Eastern Municipal Water District (EMWD) - (11) Asbestos Surveys
LOCATION: 37950 Warren Road
San Jacinto, CA 92582

DRAWN BY: Sarah Wullenwaber

Electrical Room

22
21
25
23
26
24
### Appendix A

#### Attachment III

Asbestos Results Table

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<tr>
<th>Sample Number</th>
<th>Material Description</th>
<th>Location(s) of Material</th>
<th>Material Number</th>
<th>Asbestos Content (percent)</th>
<th>Asbestos Regulatory Classification</th>
<th>Approximate Quantity</th>
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ND = Not detected    N/A = Not applicable

**FRIABLE ASBESTOS-CONTAINING MATERIAL** is material containing more than one percent (1%) asbestos that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

**CLASS I NONFRIABLE ASBESTOS-CONTAINING MATERIAL** is material containing more than one percent (1%) asbestos, and that, when dry, can be broken, crumbled, pulverized, or reduced to powder in the course of demolition or renovation activities. Actions which may cause material to be broken, crumbled, pulverized, or reduced to powder include physical wear and disturbance by mechanical force, such as, but not limited to, sanding, sandblasting, cutting or abrading, improper handling or removal or leaching of matrix binders. Class I nonfriable asbestos-containing material includes, but is not limited to, fractured or crushed asbestos cement products, transite materials, mastic, roofing felts, roofing tiles, cement water pipes and resilient floor covering.

**CLASS II NONFRIABLE ASBESTOS-CONTAINING MATERIAL** is all other material containing more than one percent (1%) asbestos, that is neither friable nor Class I nonfriable.

**NOTE:** This summary table must not be used alone. Important explanations and limitations are contained in the accompanying survey report text. Percent asbestos content is based upon visual area estimation (point count or TEM analysis was not performed), unless noted otherwise in the table. See laboratory Bulk Asbestos Analysis report(s) for percent asbestos content of each layer.

*All quantities are approximate. Contractors submitting bids for work must field verify quantities.*
FRIABLE ASBESTOS-CONTAINING MATERIAL is material containing more than one percent (1%) asbestos that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

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*All quantities are approximate. Contractors submitting bids for work must field verify quantities.
Appendix A

Attachment IV

Laboratory Report with Chain of Custody
**Bulk Asbestos Analysis**


NVLAP Lab Code: 101459-0

Forensic Analytical Consulting Svcs
Julie Zak
7625 Sunrise Blvd.
Suite 104
Citrus Heights, CA 95610

Client ID: SAC02
Report Number: B301018
Date Received: 03/02/20
Date Analyzed: 03/09/20
Date Printed: 03/09/20
First Reported: SAC02PJ45534; EMWD Main 2270 Trumble Road Perris CA 92570

### Job ID/Site:
PJ45534; EMWD Main 2270 Trumble Road Perris CA 92570

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--- | --- | --- | --- | --- | --- | --- | ---
SL-112-26 | 12278395 | Beige Mortar | ND | Beige Mortar | ND | Beige Mortar | ND
Layer: Beige Mortar
Layer: Paint

**Total Composite Values of Fibrous Components:**
- Asbestos (ND)
- Cellulose (Trace)

Tad Thrower, Laboratory Supervisor, Hayward Laboratory

**Note:** Limit of Quantification ('LOQ') = 1%. 'Trace' denotes the presence of asbestos below the LOQ. 'ND' = 'None Detected'.

Analytical results and reports are generated by SGS Forensic Laboratories (SGSFL) at the request of and for the exclusive use of the person or entity (client) named on such report. Results, reports or copies of same will not be released by SGSFL to any third party without prior written request from client. This report applies only to the sample(s) tested. Supporting laboratory documentation is available upon request. This report must not be reproduced except in full, unless approved by SGSFL. The client is solely responsible for the use and interpretation of test results and reports requested from SGSFL. SGSFL is not able to assess the degree of hazard resulting from materials analyzed. SGS Forensic Laboratories reserves the right to dispose of all samples after a period of thirty (30) days, according to all state and federal guidelines, unless otherwise specified. All samples were received in acceptable condition unless otherwise noted.
### SAMPLING DATA FORM

**CLIENT:** SAC02 FACS Sacramento  
CSI Services, Inc.  

**Site:** EMWD Main, 2270 Trumble Road, Perris CA 92570  

**Sampled by:** Alex Zhidenyuk  

**Phone/Fax:** 916-726-1803  
**Sample Date:** 2/27/2020  
**Turnaround Time:** 24 hr  
**Analysis:** X PLM Standard  
**PM:** Julie Zak  
**FACS Job Number:** PJ45534  

**Material Description** | **Material Location(s)** | **Approx. Quant.** | **Friable?** | **Cond.** | **Sample Number** | **Sample Location** | **Photo #**  
---|---|---|---|---|---|---|---  
Gray concrete | Wet Well Walls | 200SF | N | good | SL-101-01 | Wet Well wall, 1 ft from ground |  
Gray concrete | Wet Well Manhole exterior color | 10 SF | N | good | SL-102-04 | Wet Well exterior color, south |  
Gray concrete | Dry well | 550SF | N | good | SL-103-06 | Dry Well, Lower Level, Pump Base, Position |  
Gray concrete | Red Primer + Blue Paint | Position 1 Pump | 60 SF | N | fair | SL-104-09 | Position 1 Pump, motor |  
Blue Paint | Position 2 Pump | 40SF | N | good | SL-105-11 | Position 1/2 connection |  

** Dw = Gypsum = Joint Compound  
VFT = Vinyl Floor Tile  
BB = Baseboard  
MAS = Mastic  
ADH = Adhesive  
FP = Fireproofing  
VSF = Vinyl Sheet Flooring  
ACT/P = Acoustic Ceiling Tile/Panel  
ACS = Sprayed-on Acoustical Ceiling Material  
WT = Wall Texture  
FD = Fire Door  
TSI = Thermal System Insulation  
EJ = Expansion Joint  
PEN = Penetration  

**Sample & Relinquished by:** Alex Zhidenyuk  
**Date & Time:** 2/27/2020  
**Received by:**  
**Date & Time:**  

**Relinquished by:**  
**Date & Time:**  
**Received by:**  
**Date & Time:**
# SAMPLING DATA FORM

**CLIENT:**
SAC02 FACS Sacramento  
CSI Services, Inc.

**Phone/Fax:** 916-726-1303  
**Sample Date:** 2/27/2020

**Turnaround Time:** _24 hr_ _48 hr_ _Extended (5 days)_ _Rush_

**Analysis:**  
- PLM Standard  
- PLM Point Count

**Special Instructions:** E-mail results to see@forensicanalytical.com

**PM:** Julie Zak

**Site:** EMWD Main, 2270 Trumble Road, Perris CA 92570

**Sampled by:** Alex Zhdanovuk  
**FACS Job Number:** PJ45534

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<th>Friable?</th>
<th>Cond.</th>
<th>Sample Number</th>
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<td>fair</td>
<td>SL-10512</td>
<td>Position 1 Piping, Flange</td>
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<td>Red Paint</td>
<td>Wet well flange</td>
<td>20SF</td>
<td>N</td>
<td>good</td>
<td>SL-10613</td>
<td>Position 1 Flange</td>
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<tr>
<td>Red Paint</td>
<td>Wet well flange</td>
<td>N</td>
<td></td>
<td></td>
<td>SL-10614</td>
<td>Position 1 Flange</td>
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<td>good</td>
<td>SL-10715</td>
<td>Bubble Controls, Top</td>
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<td>N</td>
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<td>Bubble Controls, Door</td>
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<td></td>
<td>SL-10818</td>
<td>PB 1 box</td>
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<td>Valve vault</td>
<td>10SF</td>
<td>N</td>
<td>fair</td>
<td>SL-10919</td>
<td>Valve vault pipe, east side</td>
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<td>Black Coating</td>
<td>Valve vault</td>
<td>N</td>
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<td></td>
<td>SL-10920</td>
<td>west side</td>
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<td>Gray Caulking</td>
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<td>50SF</td>
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<td>Entrance to Blvd</td>
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<td>N</td>
<td></td>
<td></td>
<td>SL-11022</td>
<td>Pedestrian anti-slip plate</td>
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**SKU:**  
- DW = Gypsum  
- JC = Joint Compound  
- VFT = Vinyl Floor Tile  
- BB = Baseboard  
- MAS = Mastic  
- ADH = Adhesive  
- FP = Fireproofing  
- VSF = Vinyl Sheet Flooring  
- ACT/P = Acoustic Ceiling Tile/Panel  
- ACS = Sprayed-on Acoustical Ceiling Material  
- WT = Wall Texture  
- FD = Fire Door  
- TSI = Thermal System/Insulation  
- Exp. Jt. = Expansion Joint  
- PEN = Penetration

**Sample & Relinquished by:**  
**Date & Time:** 2/27/2020 2:00  
**Received by:**  
**Date & Time:**

**Relinquished by:**  
**Date & Time:**

**Received by:**  
**Date & Time:**
**SAMPLING DATA FORM**

**CLIENT:**
SAC02 FACS Sacramento
CSI Services, Inc.

**Site:** EMWD Main, 2270 Trumble Road, Perris CA 92570

**Sampled by:** Alex Zlidance

**FACS Job Number:** PJ45534

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<td>North East corner</td>
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**Phone/Fax:** 916-726-1305  
**Sample Date:** 2-27-2020

**Turnaround Time:** 24 hr 48 hr Extended (5 days) Rush

**Analysis:** X PLM Standard  
**Special Instructions:** E-mail results to sac@forensicanalytical.com

**PM:** Julie Zak

---

**DW = Gypsum   JC = Joint Compound   VFT = Vinyl Floor Tile   BB = Baseboard   MAS = Mastic   ADH = Adhesive   FP = Fireproofing**

**Square Feet: SF; Linear Feet: LF**

**Friable: Yes / No**

**Condition: 1 Good/ 2 Damaged/ 3 Significant Damage**

**Sampled & Relinquished by:**

**Date & Time:** 2/27/2020

**Received by:**

**Date & Time:** MAR 02 2020

**Date & Time:**

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**Date & Time:**

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**Date & Time:**
Appendix B

Representative Photographs

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<tr>
<th>Photo 1: Skinner 1 Lift Station – wet and dry wells overview</th>
<th>Photo 2: Skinner - wet well concrete walls (101)</th>
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<td>Photo 3: Skinner - wet well access (102)</td>
<td>Photo 4: Skinner - dry well entrance (103)</td>
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<td><img src="image3.jpg" alt="Photo 3" /></td>
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Appendix B

Representative Photographs

Photo 5: Blue paint with red primer (104)

Photo 6: Green paint – piping flange (105)

Photo 7: Red paint – dry well flange (106)

Photo 8: Beige and gray paint – electrical boxes and panels (107 - 108)
Appendix B

Representative Photographs

Photo 9: Black coating – valve vault (109)

Photo 10: Gray caulking – electrical room at base (110)

Photo 11: Gray concrete – electrical room (111)

Photo 12: Electrical room, general view
Appendix C

Certification of Personnel
Forensic Analytical Consulting Services
James M Rich
7625 Sunrise Blvd., Suite 104
Citrus Heights CA 95610

Dear Certified Asbestos Consultant or Technician:

Enclosed is your certification card. **To maintain your certification, you must abide by the rules printed on the back of the certification card.**

Your certification is valid for a period of one year. If you wish to renew your certification, you must apply for renewal at least 60 days **before** the expiration date shown on your card. [8 CCR 341.15(h)(1)].

Please hold and do not send copies of your required AHERA refresher renewal certificates to our office until you apply for renewal of your certification.

Certificates must be kept current if you are actively working as a CAC or CSST. The grace period is only for those who are not actively working as an asbestos consultant or site surveillance technician.

Please notify our office via U.S. Postal Service or other carrier of any changes in your mailing or work address within 15 days of the change.

Sincerely,

Jeff Ferrell
Senior Safety Engineer

Attachment: Certification Card

cc: File

Renewal – Card Attached 08/2019
Forensic Analytical Consulting Services
Oleksandr Zhdanyuk
7625 Sunrise Boulevard
Citrus Heights CA 95610

February 13, 2020

Dear Certified Asbestos Consultant or Technician:

Enclosed is your certification card. To maintain your certification, you must abide by the rules printed on the back of the certification card.

Your certification is valid for a period of one year. If you wish to renew your certification, you must apply for renewal at least 60 days before the expiration date shown on your card. [8 CCR 341.15(h)(1)].

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Please notify our office via U.S. Postal Service or other carrier of any changes in your mailing or work address within 15 days of the change.

Sincerely,

Jeff Ferrell
Senior Safety Engineer

Attachment: Certification Card

cc: File

Renewal – Card Attached 08/2019
June 14, 2019

Julie L Zak
P O Box 177
Forestville CA 95436-0177

Dear Certified Asbestos Consultant or Technician:

Enclosed is your certification card. To maintain your certification, you must abide by the rules printed on the back of the certification card.

Your certification is valid for a period of one year. If you wish to renew your certification, you must apply for renewal at least 60 days before the expiration date shown on your card. [8 CCR 341.15(h)(1)].

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Please contact our office at the above address or email with any changes in your contact/mailing information within 15 days of the change.

Sincerely,

Jeff Ferrell
Senior Safety Engineer

Attachment: Certification Card

cc: File

Renewal – Card Attached (Revised 01/10/2019)
APPENDIX I

PAINT SAMPLE ANALYSIS REPORT
Limited Industrial Hygiene CAM 17 Metals Waste Characteristic Assessment

Performed at
Lake Skinner Recreational Park
37701 Warren Road
Winchester, CA 92596

Performed on May 28, 2020

Submitted To
Mr. Jeff Allred, PE
Civil Engineer, Engineering Department
Eastern Municipal Water District
2270 Trumble Road
Perris, CA 92570

HSA Project Number 200219LA

June 15, 2020

Prepared By:

JanMarie Bailey
Industrial Hygienist

Reviewed By,

Joel I. Berman, CIH, CSP, CAC, CIAQM
Vice President
EXECUTIVE SUMMARY

On May 28, 2020, Health Science Associates (HSA) performed a limited Industrial CAM 17 Metals Waste Characteristic Assessment at Skinner I Lift Station located in Lake Skinner Park in Winchester, California.

The assessment was performed to determine if the paint on various pieces of equipment in the dry lift station were potentially hazardous waste in accordance with the California Title 22, §66261.24 hazardous waste standards for metals.

In total, nine (9) paint chip samples were collected utilizing accepted professional methodologies for the collection of bulk waste samples. The barium results for sample numbers 200528-01 and 200528-02 and the zinc results for sample numbers 200528-05, 200528-08, and 200528-09 were above the Calif. Title 22 - Total Threshold Limit Conc. (TTLC), Section 66261.24, Table II regulatory levels. Therefore, paint chip waste generated from these components should be segregated and further analyzed in accordance with the Soluble Threshold Limit Concentration (STLC) and the Waste Extraction Test to comply with all local, State and Federal laws.

This report was prepared for use by Eastern Municipal Water District in evaluating the subject location. The information contained within this report is as factual as possible and the opinions related herein are based on HSA’s experience in similar investigations. No warranty, therefore, is made to any persons other than Eastern Municipal Water District regarding the conclusions or recommendations included within this report. HSA will not release copies to a third party without prior written consent of Eastern Municipal Water District.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>i</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>ii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2.0 METHODS.</td>
<td>1</td>
</tr>
<tr>
<td>3.0 STANDARDS AND GUIDELINES</td>
<td>2</td>
</tr>
<tr>
<td>4.0 SURVEY RESULTS, DISCUSSION, AND RECOMMENDATIONS</td>
<td>2</td>
</tr>
<tr>
<td>Table I - Bulk Sampling Results for Metals</td>
<td>4</td>
</tr>
<tr>
<td>APPENDIX I - LABORATORY REPORTS</td>
<td></td>
</tr>
<tr>
<td>APPENDIX II - FIGURE</td>
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<td>Appendix III - Photographs</td>
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INTRODUCTION

1.1 On May 28, 2020, Health Science Associates (HSA) performed a limited Industrial CAM 17 Metals Waste Characteristic Assessment at Skinner I Lift Station located in Lake Skinner Park in Winchester, California.

1.2 Project sampling was performed by Devin S. Berman, California Certified Asbestos Consultant (CAC - Cert. # 15-5418), California Department of Public Health (CDPH) Certified Lead Inspector/Assessor (I/A - LRC - 00002357).

1.3 Report preparation was performed by JanMarie Bailey, Industrial Hygienist (IH). Project Management and report review were performed by Joel I. Berman, Certified Industrial Hygienist (CIH), Certified Safety Professional (CSP), Certified Asbestos Consultant (CAC), Certified Indoor Air Quality Manager (CIAQM), CDPH Certified Lead Inspector/Assessor (I/A - LRC - 00003608) and Project Monitor (PM - LRC00003607), Vice President.

1.4 Nine (9) bulk paint chip samples were collected and submitted for CAM 17 metals analysis in accordance with Inductively Coupled Plasma (ICP), EPA method 6010B.

1.5 The sampling results were then evaluated and compared with reference to levels regulated by California Title 22, §66261.24 hazardous waste standards for metals.

2.0 METHODS

2.1 Analytical Methodology

The bulk paint sampling and analytical methodologies employed followed NIOSH, OSHA, EPA, and/or other professionally accepted sampling methods. The specific method is reported on the laboratory reports and sampling data sheets, which include chain-of-custody (COC) signatures.

2.2 Laboratory

After sample collection, all samples were transported via chain-of-custody procedures to LA Testing’s Huntington Beach, CA laboratory for analysis. LA Testing is part of a larger, nation-wide laboratory organization known as EMSL. These laboratories maintain accreditations by the American Industrial Hygiene Association (AIHA), the National Voluntary Laboratory Accreditation Program (NVLAP), the California Department of Public Health Environmental Laboratory Accreditation Program (ELAP), and AIHA’s Environmental Lead Laboratory Accreditation Program (ELLAP).
3.0 STANDARDS AND GUIDELINES

3.1 Lead and other Metal Waste

3.1.1 Lead and other metal wastes are regulated under California Title 22, §66261.24. The standard defines lead hazardous waste as greater than >1,000 milligrams per kilogram (mg/kg) of lead and/or lead compounds determined as a Total Threshold Limit Concentration (TTLC) or 5.0 milligrams per liter (mg/l) determined as a Soluble Threshold Limit Concentration (STLC) or Waste Extraction Test (WET) method.

3.1.2 Under California Title 22, other metal wastes are also regulated.

3.1.3 Federal EPA under the Resource Conservation and Recovery Act (RCRA) also mandates hazardous waste criteria for lead that is tested by the Toxicity Characteristic Leaching Procedure (TCLP). This method sets a limit for the quantity of lead that can be “soluble” or leach into the water. The EPA maximum toxicity characteristic for lead is equal to or greater than >5.0 mg/l.

3.1.4 Other Regulations and Guidelines

California Title 8, CCR §5194, Hazard Communication Standard, requires employers to notify their employees of hazardous materials in their workplace.

4.0 SURVEY RESULTS, DISCUSSION, AND RECOMMENDATIONS

4.1 The laboratory reports with chain-of-custody documentation are provided in Appendix I; Figures used to depict sampling locations are in Appendix II; Photographs are in Appendix III.

4.1.1 HSA collected a total of nine (9) paint chip samples for laboratory analysis. The results, descriptions and analytical results are presented in Table I Bulk Sampling Results for Metals.

4.2 Results Summary

4.2.1 The barium results for sample numbers 200528-01 and 200528-02 and the zinc results for sample numbers 200528-05, 200528-08, and 200528-09 were above the Calif. Title 22 - Total Threshold Limit Conc. (TTLC), Section 66261.24, Table II regulatory levels. Therefore, prior to disposal the paint
chip waste generated from these components should be segregated and further analyzed in accordance with the Soluble Threshold Limit Concentration (STLC) and the Waste Extraction Test to comply with all local, State and Federal laws.

4.2.2 Care should be taken when performing any activities (e.g. manually dry sanding or scraping surfaces) to prepare any of the component(s) either determined to be coated with or which are suspected of containing lead for repainting.

4.2.3 Waste should be segregated and a waste profile should be conducted on paint chips, and other wastes possibly contaminated with or containing lead or other metals to comply with all local, State and Federal laws.

4.2.4 Due to the nature, age, and use of the structure, hidden or unknown suspect ACM/ACCM, lead or other hazardous materials may be uncovered during renovation/maintenance activities. Therefore, all contractors working on the project should be informed of policies with regard to notifying management if previously unidentified suspect hazardous materials are discovered during the project.

4.2.5 Disclaimer

These results and this evaluation are based upon conditions and operations present during the dates and times of this survey.

4.3 This report was prepared for use by Eastern Municipal Water District’s in evaluating the subject location. The information contained within this report is as factual as possible and the opinions related herein are based on HSA’s experience in similar investigations. No warranty, therefore, is made to any persons other than Eastern Municipal Water District’s regarding the conclusions or recommendations included within this report. HSA will not release copies to a third party without prior written consent of Eastern Municipal Water District’s.
### Table I - Bulk Sampling Results for Metals

**HSA Project No.:** 200219LA  
**Project:** Eastern Municipal Water District, 37701 Warren Road, Winchester, CA 92596  
**Date:** May 28, 2020  
**Ind. Hyg.:** D. Berman, CDPH I/A, (LRC - 00002357)

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Location /Description</th>
<th>Ag (ppm)</th>
<th>As (ppm)</th>
<th>Ba (ppm)</th>
<th>Be (ppm)</th>
<th>Cd (ppm)</th>
<th>Cr (ppm)</th>
<th>Co (ppm)</th>
<th>Cu (ppm)</th>
<th>Hg (ppm)</th>
<th>Pb (ppm)</th>
<th>Mo (ppm)</th>
<th>Ni (ppm)</th>
<th>Sb (ppm)</th>
<th>Se (ppm)</th>
<th>Tl (ppm)</th>
<th>Va (ppm)</th>
<th>Zn (ppm)</th>
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<td>200528-03</td>
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**Standards & Guidelines**

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<th>Cal. Title 22 - Soluble Threshold Limit Conc. (STLC)</th>
<th>Federal Toxicity Characteristic Leaching Procedure (TCLP)</th>
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<td></td>
<td>500 500 10,000 75 ppm 100 ppm 500 ppm 8,000 ppm 2,500 ppm 20 ppm 1,000 ppm 3,500 ppm 2,000 ppm 500 ppm 100 ppm 700 ppm 2,400 ppm 5,000 ppm</td>
<td>5 mg/l 5.0 mg/l 100 mg/l 0.75 mg/l 1.0 mg/l 5 mg/l 80 mg/l 25 mg/l 0.2 mg/l 5.0 mg/l 350 mg/l 20 mg/l 15 mg/l 1.0 mg/l 7.0 mg/l 24 mg/l 250 mg/l</td>
<td>-- 1.0 mg/l 5.0 mg/l -- -- 0.2 mg/l 5.0 mg/l -- -- 1.0 mg/l -- -- --</td>
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TABLE II - Bulk/Wipe Sampling Results for Metals (Cont’d)

HSA Project No.: 200197LA
Project: David Starr Jordan High, Roux Associates, 2265 E 103rd Street, Los Angeles, CA 90002
Date: May 4, 2020
Ind. Hyg.: J. Berman, CIH, CSP, CAC, CDPH I/A (LRC 00003608) PM (LRC00003607)

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<th>Sample Number</th>
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<th>Ba (ppm)</th>
<th>Be (ppm)</th>
<th>Cd (ppm)</th>
<th>Cr (ppm)</th>
<th>Co (ppm)</th>
<th>Cu (ppm)</th>
<th>Hg (ppm)</th>
<th>Pb (ppm)</th>
<th>Mo (ppm)</th>
<th>Ni (ppm)</th>
<th>Sb (ppm)</th>
<th>Se (ppm)</th>
<th>Tl (ppm)</th>
<th>Va (ppm)</th>
<th>Zn (ppm)</th>
</tr>
</thead>
</table>

**Abbreviations:** ppm = parts per million; mg/l = milligrams per liter; Ag = Silver; Al = Aluminum; As = Arsenic; Ba = Barium; Be = Beryllium; Cd = Cadmium; Cr = Chromium; Co = Cobalt; Cu = Copper; Fe = Iron; Hg = Mercury; Pb = Lead; Mn = Manganese; Mo = Molybdenum; Ni = Nickel; Sb = Antimony; Se = Selenium; Tl = Thallium; Va = Vanadium; Zn = Zinc

STLC and TTLC values are calculated on the concentrations of the elements, not the compounds; * = excluding barium sulfate
APPENDIX I - LABORATORY REPORTS
### Metals in Bulk by ICP – 6010B

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<th>Lab ID</th>
<th>Client ID</th>
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<th>Reporting Limit (mg/kg)</th>
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<td>Cadmium</td>
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</table>

Sample received in acceptable condition unless otherwise noted. LA Testing dba EMSL does not hold responsibility for sampling activities. This report may not be reproduced except in full, without written approval by LA Testing. This report relates only to those items tested. Unless otherwise noted, the results in this report have not been blank corrected. Quality Control Data associated with this sample set is within acceptable limits, unless otherwise noted. The matrix spiked was out of control limit due to sample matrix interfering for Sb, Ba, Se, and Zn due to matrix interfered. *Mercury analyzed by method 7471A modified.

---

**TH**

**Analyst**

---

**Michael Chapman**

**Laboratory Manager**

Or other approved signatory
**Order ID: 332009677**

Attn: Joel Berman  
Health Science Associates  
10771 Noel Street  
Los Alamitos, CA 90720  

Email: labresults@healthscience.com  
Phone: (714) 220-3922  
Fax: (714) 220-2081  

**Customer ID:** 32HEAL56  
**Customer PO:**  
**Date Received:** 05/28/20 4:20 PM  
**LA Testing Order:** 332009677  
**Project:** 200219LA/Eastern Municipal Water District/37701 Warner Rd/Winchester, CA 92596  
**Date Analyzed:** 06/02/20

### Metals in Bulk by ICP – 6010B

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<th>Client ID</th>
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<th>Result (mg/kg)</th>
<th>Reporting Limit (mg/kg)</th>
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</tr>
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</tr>
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Sample received in acceptable condition unless otherwise noted. LA Testing dba EMSL does not hold responsibility for sampling activities. This report may not be reproduced except in full, without written approval by LA Testing. This report relates only to those items tested. Unless otherwise noted, the results in this report have not been blank corrected. Quality Control Data associated with this sample set is within acceptable limits, unless otherwise noted. The matrix spiked was out of control limit due to sample matrix interfering for Sb, Ba, Se, and Zn due to matrix interfered. *Mercury analyzed by method 7471A modified.

**TH**  
*Analyst*

**Michael Chapman- Laboratory Manager**  
Or other approved signatory

*Page 2 of 8*
## Metals in Bulk by ICP – 6010B

<table>
<thead>
<tr>
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<th>Analyte</th>
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Sample received in acceptable condition unless otherwise noted. LA Testing dba EMSL does not hold responsibility for sampling activities. This report may not be reproduced except in full, without written approval by LA Testing. This report relates only to those items tested. Unless otherwise noted, the results in this report have not been blank corrected. Quality Control Data associated with this sample set is within acceptable limits, unless otherwise noted. The matrix spiked was out of control limit due to sample matrix interfering for Sb, Ba, Se, and Zn due to matrix interfered. *Mercury analyzed by method 7471A modified.

**TH**

*Analyst*

Michael Chapman - Laboratory Manager

Or other approved signatory

Page 3 of 8
## Metals in Bulk by ICP – 6010B

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TH
Analyst

Michael Chapman- Laboratory Manager
Or other approved signatory

Page 4 of 8
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TH
Analyst

Michael Chapman- Laboratory Manager
Or other approved signatory

Page 5 of 8
### Order ID: 332009677

**Attn:** Joel Berman  
Health Science Associates  
10771 Noel Street  
Los Alamitos, CA 90720  

**Email:** labresults@healthscience.com  
**Phone:** (714) 220-3922  
**Fax:** (714) 220-2081

**Customer ID:** 32HEAL56  
**Customer PO:**  
**Date Received:** 05/28/20 4:20 PM  
**LA Testing Order:** 332009677  
**Project:** 200219LA/Eastern Municipal Water District/37701 Warner Rd/Winchester, CA 92596

**Report Date:** 06/02/20  
**Date Analyzed:** 06/02/20

---

**Metals in Bulk by ICP – 6010B**

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---

**TH**  
**Analyst**

---

**Michael Chapman**  
**Laboratory Manager**  
*Or other approved signatory*
Order ID: 332009677

Attn: Joel Berman  
Health Science Associates  
10771 Noel Street  
Los Alamitos, CA 90720  
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Project: 200219LA/Eastern Municipal Water District/37701 Warner Rd/Winchester, CA 92596

Date Received: 05/28/20 4:20 PM  
Date Analyzed: 06/02/20

Metals in Bulk by ICP – 6010B

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TH  
Analyst

Michael Chapman- Laboratory Manager  
Or other approved signatory
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---

**TH**

*Analyst*

**Michael Chapman - Laboratory Manager**

*Or other approved signatory*
# LEAD BULK SAMPLE DATA SHEET

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<th>Sample #</th>
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<th>Location / Description / XRF #</th>
<th>Notes / Instructions</th>
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Laboratory Reporting Units:
- Wipe in µg/ft²
- Soil in ppm
- Waste Water in ppm
- Drinking Water in ppm
- Lead Waste in TTLC, STLC, TCLP (circle all that apply)

Analytical Method:
- FAAS
- ICP
- GFAS

Special Instructions to Laboratory:
- See Joel's email for metals list

Relinquished by: Joel Berman  Date: 5/28/20  Time: 12:16
Relinquished by:  Date:  Time:
Relinquished by:  Date:  Time:
## LEAD BULK SAMPLE DATA SHEET

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<th>Project Manager: Joel Berman</th>
<th>Project #: 200219LA</th>
<th>Date: 5/28/2020</th>
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<td>Client:</td>
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<td></td>
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<tr>
<td>Project Location:</td>
<td>37701 Warren Rd, Winchester, CA 92596</td>
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</tr>
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<td>Paint Chip</td>
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<tr>
<td>200528-09</td>
<td>Paint Chip</td>
<td>Black paint ppe metal</td>
<td>In valve vault</td>
</tr>
</tbody>
</table>

### Laboratory Reporting Units:
- Wipe in µg/ft²
- Soil in ppm
- Waste Water in ppm
- Drinking Water in ppb
- Lead Waste in TTLC, STLC, TCLP (circle all that apply)

### Analytical Method
- Paint Chip in WT %
- Paint Chip in mg/cm²
- FAAS
- ICP
- GFAS

### Special Instructions to Laboratory:
See Joel’s email for metals list

### Relinquished by:
- Devin S. Berman
- Date: 5/28/2020
- Time: 12:10
- Received by:
- Date: 5/28/20
- Time: 12:20

### Relinquished by:
- Date: 
- Time: 
- Received by: 
- Date: 
- Time: 

### Relinquished by:
- Date: 
- Time: 
- Received by: 
- Date: 
- Time: 
Bulk Asbestos Sample Locations
EB-Electrical Box
13. Electrical box on North wall
14. Electrical boxes on West wall
15. Electrical boxes on South wall
16. Bottom floor