CITY OF COLUSA

Department of Public Works

CONTRACT DOCUMENTS
FOR

2026 WILL S. GREEN AVENUE PUMP STATION PROJECT

CITY PROJECT NO. 2026-020
SRF LOAN PROJECT NO. C-06-8613-110
VOLUME 2

PRE BID MEETING – August 5th, 2026, 10:00 a.m. at Project Site
BID OPENING – August 20th, 2026, 3:00p.m. at City Hall

Mayor:	Denise Conrado
Mayor Pro Tem:	Dave Markss
Council Members:	Ryan Codorniz Greg Ponciano Daniel Vaca
City Manager:	Jesse Cain
Public Works Administrative Director:	Jesse Cain

TABLE OF CONTENTS
CITY OF COLUSA 2026 WILL S. GREEN AVENUE PUMP STATION PROJECT
IN THE CITY OF COLUSA, CALIFORNIA

CITY PROJECT NO. 2026-020

VOLUME 2: TECHNICAL SPECIFCATIONS
DIVISION 1 -17

DIVISION 1:	GENERAL REQUIREMENTS
01010	GENERAL CONSTRUCTION INFORMATION AND REQUIREMENTS
01020	MODIFICATION OF EXISTING FACILITIES AND ORDER OF WORK
01050	SURVEY CONTROL
01200	PAYMENT PROCEDURES
01300	SUBMITTALS
01305	PROJECT MEETINGS
01310	CONSTRUCTION SCHEDULE
01320	SCHEDULE OF VALUES
01330	SAFETY PLAN
01340	REQUESTS FOR INFORMATION AND CLARIFICATIONS
01354	HAZARDOUS MATERIAL PROCEDURES
01410	REGULATORY REQUIREMENTS
01500	TEMPORARY FACILITIES AND CONTROLS
01610	SEISMIC ANCHORAGE AND BRACING
01611	SEISMIC DESIGN REQUIREMENTS
01620	QUALITY CONTROL AND INSPECTION
01640	PRODUCT REQUIREMENTS AND HANDLING
01666	TESTING OF GRAVITY SEWER LINES AND MANHOLES
01667	TESTING OF PIPELINES
01700	CONTRACT CLOSEOUT

DIVISION 2:	**SITEWORK**
02010	SUBSURFACE CONDITIONS
02100	DEMOLITION, CLEARING, GRUBBING, AND STRIPPING
02140	DEWATERING
02210	SITE GRADING
02221	UTILITY TRENCHING AND BACKFILL
02223	TRENCHING BACFILLING AND COMPACTING
02225	STRUCTURE EXCAVATION AND BACKFILL
02229	UTILITY LINE MARKING
02233	WATERING
02270	STORMWATER RUNOFF CONTROL PROGRAM
02272	VEGETATIVE EROSION CONTROL
02273	CONSTRUCTION ACTIVITIES STORMWATER BEST MANAGEMENT PRACTICES
02400	SHEETING, WALING, AND SHORING
02445	ORNAMENTAL FENCE
02450	ORNAMENTAL CANTILEVER ROLLING GATES
02513	ASPHALT CONCRETE PAVING
02601	MANHOLES AND CLEANOUTS
02621	FILTER FABRIC
DIVISION 3:	**CONCRETE**
03071	EPOXIES
03100	CONCRETE
03110	CONTROLLED LOW STRENGTH MATERIALS
03480	PRECAST UTILITY VAULTS AND CATCH BASINS
03700	CONCRETE SAW-CUTTING AND CORE-DRILLING
DIVISION 4:	**MASONRY (NOT USED)**
DIVISION 5:	**METALS**
05500	METAL FABRICATIONS
05501	ANCHOR BOLTS AND ANCHORING DEVICES

DIVISION 6:	**WOOD AND PLASTICS (NOT USED)**
DIVISION 7:	**THERMAL AND MOISTURE PROTECTION**
07920	CAULKING AND SEALANTS
DIVISION 8:	**DOORS AND FRAMES**
08310	ACCESS HATCHES
08710	DOOR HARDWARE
DIVISION 9:	**FINISHES**
09900	PAINTING & FINISH SCHEDULE
DIVISION 10:	**SPECIALTIES**
10400	IDENTIFYING DEVICES
DIVISION 11:	**EQUIPMENT**
11010	GENERAL MECHANICAL EQUIPMENT PROVISIONS
11302	SUBMERSIBLE SEWAGE PUMPS
11351	RECYCLED WATER BOOSTER PUMP STATION
11805	DIESEL-ENGINE-DRIVEN GENERATOR SET
DIVISION 12:	**FURNISHINGS (NOT USED)**
DIVISION 13:	**SPECIAL CONSTRUCTION**
13120	PRECAST CONCRETE BUILDING
DIVISION 14:	**CONVEYING SYSTEM (NOT USED)**
DIVISION 15:	**MECHANICAL**
15010	GENERAL PROCESS AND ONSITE UTILITY PIPING PROVISIONS
15051	STEEL PIPE
15062	DUCTILE IRON PIPE
15071	PLASTIC PIPE
15085	PIPING ACCESSORIES AND APPURTENANCES
15094	HANGERS AND SUPPORTS
15100	VALVES
15790	SPLIT SYSTEM AIR CONDITIONER/HEAT PUMP
DIVISION 16:	**GENERAL ELECTRICAL**

16050	GENERAL ELECTRICAL WORK
16070	SEISMIC RESTTRAINTS AND SUPPORTS
16110	ELECTRICAL RACEWAY SYSTEMS
16111	UNDERGROUND RACEWAY SYSTEMS
16120	WIRE AND CABLING
16125	SINGLE MODE FIBER OPTIC GENERAL REQUIREMENTS
16140	WIRING DEVICES
16150	ELECTRIC MOTORS
16155	LOW VOLTAGE MOTOR CONTROL CENTER
16250	TRANSFER SWITCHES
16431	PROTECTIVE DEVICE STUDIES
16450	GROUNDING
16460	LOW VOLTAGE TRANSFORMERS AND SWITCH GEAR
16470	PANELBOARDS AND DRY TYPE TRANSFORMERS
16473	ELECTRICAL UTILITY SERVICE
16485	INDUSTRIAL CONTOL PANELS
16500	LIGHTING
16671	SURGE PROTECTION DEVICES
16950	ELECTRICAL TESTS

DIVISION 17: INSTRUMENTATION AND CONTROLS

17010	INSTRUMENTATION AND CONTROL PROCESS SYSTEMS
17110	CONTROL PANELS
17702	IN-LINE LIQUID FLOW MEASURING
17710	PLC-BASED CONTROL SYSTEM HARDWARE
17725	INDUSTRIAL NETWORK HARDWARE
17800	TESTING CALIBRATION AND INSTALLATION VERIFICATION
17830	INSTRUMENTATION AND CONTROL TEST FORMS

SECTION 01010

GENERAL CONSTRUCTION INFORMATION AND REQUIREMENTS

PART 1: GENERAL

1.01 DESCRIPTION

This section covers the general requirements for the Contractor's temporary facilities at the job site and for the prosecution of the work.

Both requirements of Section 00700 General Conditions and Section 01010 General Construction Information and Requirements shall equally apply to the extent that these conditions and requirements are supplemental and in agreement. If a conflict occurs, Section 00700 General Conditions shall take precedence over any conflicting information in Division 1, Sections 01010, 01200, 01300, 01305, 01310, 01320, 01330, 01340, 01354 and 01410.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01020: Modification of Existing Facilities and Order of Work

B. Section 01300: Submittals

C. Section 01330: Safety Plan

D. Section 01700: Contract Closeout

E. Section 02513: Asphalt Concrete Paving

F. Section 02273: Construction Activities Stormwater Best Management Practices

G. Section 11010: General Mechanical Equipment Provisions

H. Division 16: Electrical

I. Division 17: Instrumentation

1.03 GENERAL NATURE OF THE WORK

A. The work involves furnishing of labor, equipment, and materials necessary to construct the Will S Green Pump Station, including, but not limited to:

1. Site grading including raising general site approximately 3-4 feet.

2. Furnishing and installation of a new wastewater pump station at the Will S Green Pump Station site as shown on the drawings.

3. Furnishing and installation of four (4) pre-cast concrete manholes as identified in the drawings.

4. Furnishing and installation of four (4) submersible pumps and manufacturer supplied control panels.

5. Furnishing and installation of a new flow meter, asphalt concrete roadway, aggregate base, drainage pipelines, and drop inlets.

6. Furnishing and installation of a new pre-cast concrete building for the housing of electrical components as identified on the drawings.

7. Furnishing and installation of new fencing and motorized rolling gates as identified on the drawings.

8. Furnishing and installation of a skid-mounted recycled water booster pump station and associated piping on the Will S. Green Pump Station site.

9. Furnishing and installation of a new backup generator.

10. Furnishing and installation of all electrical systems and controls for the new PG&E service, new pump station, fiber, flow meters, gate operators, generator, and site lighting.

B. Except as specifically noted otherwise, the Contractor shall provide and pay for:

1. Insurance and bonds.

2. Labor, materials, and equipment.

3. Tools, equipment, and machinery required for construction.

4. Utilities required for construction.

5. Temporary facilities including sheeting and shoring.

6. Traffic control and dust control measures.

7. Other facilities and services necessary for proper execution and completion of the Work.

C. The Contractor shall secure and pay for all permits including, but not limited to, OSHA excavation permits, Storm Water Pollution Prevention Permit, Department of Transportation permits, government fees, and licenses.

D. The Contractor shall comply with codes, ordinances, regulations, orders, and other legal requirements of public authorities having bearing on the performance of the Work.

1.04 LOCATION OF THE PROJECT SITE

The project site is located on 1480 Will S. Green Avenue, adjacent to the Pirelli Cable Corp along Will S Green Ave., in the City of Colusa, Colusa County, California.

1.05 ACCESS TO THE SITE

Access to the project site shall be as shown on the plans or as directed by the Engineer.

1.06 ACTIVITIES BY OTHERS

A. OWNER, utilities, and others may perform activities within Project area while the Work is in progress.

1. Schedule the Work with Owner, utilities, and others to minimize mutual interference.

2. Linear work that connects to this project within the Will S. Green Avenue right-of-way will be performed under a separate contract.

B. Cooperate with others to minimize interference and delays.

1. When cooperation fails, submit recommendations, and perform Work in coordination with work of others.

1.07 COORDINATION OF WORK

A. Maintain overall coordination of the Work.

B. Obtain construction schedules from each subcontractor and require each subcontractor to maintain schedules and coordinate modifications.

C. Agency shall provide software for construction management. The contractor shall use the software to communicate with the Agency. The software shall be used for document management, finance controls, reporting, administration, Construction documents (RFIs, Submittals, and Inspection Schedules).

1.08 EARLY OCCUPANCY OF PORTIONS OF WORK

A. Certificates of Substantial Completion will be executed for each designated portion of Work prior to Owner occupancy.

1. Such certificate of Substantial Completion will describe the portion of the Work to be occupied by Owner, items that may be incomplete or defective,

date of occupancy by Owner, and other information required by Owner and Contractor.

B. After Owner occupancy, allow access for Owner's personnel, access for others authorized by Owner, and Owner operation of equipment and systems.

C. Following occupancy, Owner will:

1. Provide power to operate equipment and systems.

2. Provide chemicals to operate equipment and systems (i.e. polymer)

3. Repair damage caused by Owner's occupancy.

PART 2: MATERIALS

2.01 MATERIALS

See Divisions 2 through 16 for materials and methods of installation.

PART 3: EXECUTION

3.01 GENERAL

A. Protection/Operation of Existing Facilities - A primary concern of the Owner is the protection and operation of the Owner's facilities. The Contractor will not be allowed to operate any existing valves or to cause a shutdown of any portion of the system. Operation of valves will be done by the owner's personnel only. Any planned shutdown shall be discussed at the preconstruction meeting or at least five (5) working days in advance of the work. Shutdowns will be allowed only if no other reasonable alternative exists, such as the use of a "hot-tap" connection. When shutdowns are required, the Owner will make an evaluation of whether the shutdown should be done during the day, during the night, or on a weekend. The/Contractor's economics will be weighed less heavily in the decision than in the interruption and inconvenience to existing customers. Any shutdown will require the approval of a notification plan for existing customers by the Owner

B. Utilities and Existing Facilities - The Contractor shall contact all owners of underground facilities known to be in the area of construction and request marking of these facilities through Underground Service Alert (USA). A two (2) working day notice is required.

The fact that any underground utility and/or facility is not shown on the plans shall not relieve the Contractor's responsibility to comply with these standards. It shall be the Contractor's responsibility to ascertain, prior to commencing work, the existence of any underground utilities within the construction area.

The Owner will locate its facilities upon satisfactory advanced notification.

3.01 CONTRACTOR'S PLANT AND EQUIPMENT

A. Security: The Contractor shall at all times be responsible for the security of his plant and equipment. The Owner will not take any responsibility for missing or damaged equipment, tools or personal belongings.

B. Contractor's Field Office: The Contractor's representative shall be on-site and maintain an on-site mobile office with copies of files and permits necessary for the work. The Contractor's representative shall have a cellular telephone for communication with the District and the Engineer while at the job site.

The Contractor may place a construction field office at a location adjacent to the site or at the City wastewater treatment plant as approved by the engineer.

C. Workshop and Storage Facilities: The Contractor shall provide storage buildings for the protection of equipment, materials, supplies and tools. The building used for the storage of materials which deteriorate when exposed to moisture shall be moisture proof. Workshops and storage buildings shall be located as designated by the Engineer and shall be always clean and in proper order.

D. Parking Facilities: Parking areas at the project site for visitor parking, employee vehicles, and the vehicles used by the Contractor's construction employees shall be designated by the Engineer.

3.02 CONTRACTOR'S UTILITIES

A. Power: The Contractor shall be responsible for obtaining and maintaining power for the purposes of construction, and for any field offices or ancillary structures installed by the Contractor for his use during construction.

B. Water: Recycled water used for the purposes of construction or for the Contractor's use may be available from the City of Colusa WWTP at no cost for the Contractor, in coordination with plant operations. The Contractor shall provide equipment, power and labor as required to utilize the recycled water as approved by the Engineer.

Contractor may also obtain water from City hydrants utilizing a city issued hydrant meter and with the approval of the public works department.

C. Telephone: The Contractor shall be responsible for their own cellular phone and internet service connections.

D. Sanitary Facilities: The Contractor shall be responsible for obtaining and maintaining sanitary facilities for the purposes of construction, and for any

additional field offices or ancillary structures installed by the Contractor for use during construction.

E. Temporary Heating: The Contractor shall be responsible for providing temporary heating, covering and enclosures as necessary to protect all work and material against damage by dampness and cold and to facilitate completion of the work. The Contractor shall supply all the fuel, equipment and materials required for temporary heating, in accordance with the manufacturer's recommendations.

F. The Contractor's use of the project site and facilities for personnel housing shall be subject to review and approval by the Engineer.

3.03 LANDS PROVIDED BY OWNER

The Owner will provide all lands required for the work under the contract, together with the right of access to such lands, as indicated. The Contractor shall not unreasonably encumber the premises with his equipment or materials. Periodic clean-up and debris removal is required, as directed by the Engineer.

3.04 LANDS PROVIDED BY CONTRACTOR

The Contractor shall provide, with no liability to the Owner, any additional land and access thereto not shown or described that may be required for temporary construction facilities or storage of materials. The Contractor shall construct all access roads, detour roads or other temporary works as required by his operations. The Contractor shall confine his equipment, storage of materials and operation of his workmen to those areas shown and described and such additional areas as he may provide.

3.05 PRECONSTRUCTION PHOTOS

The Contractor shall, before mobilization begins, submit electronic documentation (i.e.; Word, or PDF documents) suitable for printing, as well as the original picture files of digital photos documenting the area of work. The electronic images shall be jpeg format, at least 8 megapixels, with minimal compression. The full-size document printouts shall be at least 8.5" x 11", full color, a maximum of two prints to a page, each print a minimum size of 5 inches by 7 inches, with a printed image quality of at least 300dpi. Each printed image shall be labeled with the electronic image file name, the location and direction it was taken, and a short description of the subject. The Contractor shall take sufficient images to fully document the existing conditions of the site or facilities before work begins with special attention to facilities that are damaged prior to mobilization.

3.06 CONSTRUCTION PHOTOS

The Contractor shall, monthly and as requested by the Engineer, submit electronic documentation (i.e.; Word, or PDF documents) suitable for printing, as well as the original picture files of digital construction photos documenting the progress of the work. The electronic images shall be jpeg format, at least 8 megapixels, with minimal compression. The full-size document printouts shall be at least 8.5" x 11", full color, a maximum of two prints to a page, each print a minimum size of 5

inches by 7 inches, with a printed image quality of at least 300dpi. Each printed image shall be labeled with the electronic image file name, the location and direction it was taken, and a short description of the subject. The Engineer may designate the locations and subject of up to 50 photos each month as long as the work is in progress. Upon completion of the work, additional photos shall be taken of the subjects and locations depicted in the preconstruction photographs and submitted as described above.

3.07 SHIPPING AND PROTECTION OF EQUIPMENT

A. Definition: For the purpose of this article "equipment" means any mechanical, electrical or instrumentation devices or any items with one or more moving parts.

B. Packing and Marking:

1. All equipment shall be adequately and effectively protected against damage from moisture, dust, handling, or other causes during transport from the manufacturer's or supplier's premises to site.

2. Each item or package shall be clearly marked with a fitting or distinguishing mark which shall be shown on the packing lists. Copies of packing lists shall be delivered to the Engineer.

3. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or sub-assembled units where possible.

C. Identification of Equipment: Each item of equipment shall have firmly affixed to it a label or tag with its equipment number or other discrete identifying mark.

D. Storage of Equipment: During the interval between the delivery of equipment to the site and installation, all equipment shall be safely stored in a manner acceptable to the Engineer. Equipment shall be stored in an enclosed space affording protection from vandalism, weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Rotating equipment shall be turned or exercised as recommended by the Manufacturer.

E. Protection of Equipment After Installation: After installation, all equipment shall be protected as specified in Section 11010-1.07. During concrete operations, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switch-gear, unit substation and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed and accepted.

F. Delivery of Equipment: The Owner's personnel will not accept materials or equipment deliveries for the Contractor.

G. Protection of Existing Utilities: The Contractor shall be responsible for the care and protection of all existing water pipes, sewer pipes, gas mains, culverts, or other facilities and structures that may be encountered in or near the area of the work. In the event of damage to any existing facilities during the progress of the work and of the failure of the Contractor to exercise the proper precautions, the Contractor will pay for the cost of all repairs and protection to said facilities. The Contractor's work may be stopped until repair operations are complete.

3.08 TESTS AND INSPECTION

A. General Requirements: All materials, equipment, installation and workmanship included in this contract, if required by the Engineer, shall be tested and inspected to prove compliance with the contract requirements. No tests specified herein shall be applied until the item to be tested has been inspected and approval given for the application of such test.

1. The Owner or its representative is responsible for inspection of all excavation, pipe laying, including appurtenant structures and trench backfill from trench foundation to subgrade. All such work shall be available for inspection at all times. Two (2) business days', or forty-eight (48) hours' notice shall be given prior to the start of any construction and twenty-four (24) hours' notice for specific inspection requests. Failure to provide proper notification may delay the starting date of inspection since the Owner may not be able to inspect the work and will not accept any work for which inspection has not been arranged. The primary responsibility for compliance with all Contract requirements and standards rests with the Contractor. Any acceptance of a portion of the work by an Owner's representative does not relieve the /Contractor of this basic responsibility.
2. Field acceptance is made by the Owner Inspector and will not coincide with the date of final acceptance of the work. The TWO (2) YEAR warranty period for all work shall begin on the date of final acceptance. Any defective work discovered during this period shall be repaired or replaced and a new two (2) year period shall begin for that corrected work.
3. All overtime, holiday, or weekend inspection will be subject to Owner approval.
4. Field acceptance will be withheld until work not accepted by the Owner is reconstructed and complies with Owner Standards.

B. Tests and inspections shall include:

1. The delivery acceptance test and inspections.

2. The installed tests and inspections of items as installed.

C. Tests and inspections, unless otherwise specified or accepted, shall be in accordance with the recognized standards of the industry.

D. The form of evidence of satisfactory fulfillment of delivery acceptance test and of installed test and inspection requirements shall be, at the discretion of the Engineer, either by tests and inspections carried out in his presence or by certificates or reports of tests and inspections carried out by approved persons or organizations.

E. Delivery Acceptance Tests and Inspections: The delivery acceptance tests and inspections shall be at the Contractor's expense for any materials or equipment specified and shall include the following:

1. Test of items during the process of manufacture and/or on completion of manufacture, comprising material tests, hydraulic pressure tests, electric tests, performance and operating tests and inspections in accordance with the relevant standards of the industry and more particularly as detailed in individual sections of these specifications, or as may be required by the Engineer to satisfy himself that the items tested and inspected comply with the requirements of this contract.

2. Inspection of all items delivered at the site in order to satisfy the Engineer that such items are of the specified quality and workmanship and are in good order and condition at the time of delivery.

F. Installed Tests and Inspection:

1. All mechanical and electrical equipment shall be tested by the Contractor to the satisfaction of the Engineer before any facility is put into operation. Tests shall be specified herein and shall be made to determine whether the equipment has been properly assembled, aligned, adjusted and connected. Any changes, adjustments or replacements required to make the equipment operate as specified shall be carried out by the Contractor as part of the work and be pre-approved by the manufacturer.

2. At least 30 days before the time allowed in his construction schedule for commencing testing and start-up procedures, the Contractor shall submit to the Engineer, in duplicate, details of the procedures he proposes to adopt for testing and start-up of all mechanical and electrical equipment to be operated singly and together.

3. During the testing of equipment, the Contractor shall make available experienced factory trained representatives of the manufacturers of all the various pieces of equipment, or other qualified persons who shall instruct the Owner's personnel in the operation and care thereof. Instruction shall include step-by-step troubleshooting procedures with all necessary test equipment. All manufacturer's instructions shall be provided in writing.

4. During the performance tests, data shall be taken and recorded to demonstrate that all equipment and systems comply with the manufacturer's submitted data and other requirements of the contract.

5. If under test, any portion of the work should fail to fulfill the contract requirements and is altered, renewed or replaced, tests on that portion when so altered, removed or replaced, together with all other portions of the work as are affected thereby, shall, if so required by the Engineer, be repeated within reasonable time and in accordance with the specified conditions, and the Contractor shall pay to the Owner all reasonable expenses incurred by the Owner as a result of the carrying out of such tests.

6. If any doubt, dispute or difference should arise between the Engineer and the Contractor regarding the test results or the methods or equipment used in the carrying out of a test, the Engineer may order the test to be repeated using modified methods or equipment. If the repeat test substantially confirms the Engineer's position on the previous test, all costs in connection with the repeat test will be paid by the Contractor, otherwise the costs shall be borne by the Owner. Where the results of any installed test fail to meet the contract requirements, repeat tests to achieve the contract requirements shall be done at the Contractor's expense.

7. Any defective materials or workmanship which becomes evident within two (2) years after final acceptance shall be replaced or repaired without cost to the District. Refusal of the Developer/Contractor to correct defective work, which is clearly s/Contractor's responsibility may be just cause to bring legal action to correct the deficiencies as well as to make a claim against the warranty bond.

3.09 OPERATING AND MAINTENANCE MANUALS

A. Before receiving payment for more than 85 percent of the work or prior to the start-up of individual equipment, the Contractor shall deliver to the Engineer two hard copy sets of acceptable manufacturer's operating and maintenance instructions, and one electronic copy, covering each item of mechanical, electrical, and instrumentation equipment or equipment assembly provided under this contract, or scheduled for start-up.

B. The operating and maintenance manuals shall include, as a minimum, the following data for each item of mechanical, electrical and instrumentation equipment:

1. An itemized list of all data provided.

2. Name and location of the manufacturer, the manufacturer's local representative, the nearest supplier and spare parts warehouse, e-mail addresses for representatives, and manufacturer's web site address.

3. Accepted submittal information applicable to operation and maintenance.

4. Recommended installation, adjustment, start-up, calibration and troubleshooting procedures.

5. Recommended lubrication and an estimate of yearly quantity needed.

6. Recommended step-by-step procedures for all modes of operation.

7. Complete internal and connection wiring diagrams.

8. Recommended preventive maintenance procedures and schedule.

9. Complete parts lists, by generic title and identification number, with exploded views of each assembly.

10. Recommended spare parts.

11. Disassembly, overhaul and reassembly instructions.

C. Following the acceptable installation and operation of an item, the items' instructions and procedures shall be modified and supplemented by the Contractor to reflect all field changes or information requiring field data.

D. Before final acceptance of the project, the Contractor shall bind both sets in appropriately labeled, expanding post type binders, three-ring binders will not be allowed as substitute. Each completed binder shall contain only that material which can be held with the posts in the nonexpanded position. A complete table of contents listing all items and their location in the set shall be included in each binder with tabs denoting sections. For ready reference, the Contractor shall compile a complete list of the manufacturer's local representatives for each item provided as an appendix to the table of contents included in Volume Number 1.

E. Before final acceptance of the project, the Contractor shall provide for each piece of Equipment the manufacturer’s manual and information from paragraphs B and C as an electronic PDF file.

F. Before final acceptance of the project, the Contractor shall provide for an Excel Table with the following information for each piece of Equipment:

1. Equipment Name

2. Description

3. Manufacturer

4. Model #

5. Serial #

6. HP

7. Useful Life

8. Install Date

9. Warranty Expires

3.10 RESTORATION OF STRUCTURES AND SURFACES

A. Structures, Equipment & Pipework: The Contractor shall remove such existing structures, equipment, and pipework as may be necessary for the performance of the work and shall rebuild or replace the items thus removed to original or better condition. He shall repair any existing structures which may be damaged as a result of his work.

B. Roads and Streets: All roads and streets in which the surface is removed, broken or damaged, or in which the ground has caved or settled due to work under this contract, shall be completely restored and brought to the original grade and crown section unless otherwise indicated. Before resurfacing material is placed, edges of pavements shall be trimmed back far enough to provide clean, solid, vertical faces, and shall be free of any loose material. Roadways used by the Contractor for hauling materials, equipment, supplies, etc., shall be cleaned and repaired if the condition of the roadway is damaged or otherwise affected due to the Contractor's operations. Repaving and repairs shall be done in accordance with Section 02513 – Asphalt Concrete Paving.

C. Cultivated Areas and Other Surface Improvements: All cultivated and natural areas, either agricultural or lawns, and other surface improvements which are damaged by actions of the Contractor shall be restored, including roadside drainage ditches, as nearly as possible to their original condition or better.

3.11 SAFETY

A. The Contractor shall execute and maintain his work so as to avoid injury or damage to any person or property. All work shall be done in conformance with the State of California Division of Industrial Safety and OSHA Standards.

B. Safety precautions as applicable shall include, but not be limited to, adequate life protection, and lifesaving equipment; adequate illumination for underground and night operations; instructions in accident prevention for all employees; such machinery guards, walkways, scaffolds, ladders, bridges, and other safety devices, equipment and wearing apparel as are necessary or lawfully required to prevent accidents or injuries, and the proper inspection and maintenance of all safety measures.

C. The names' locations and telephone numbers of the nearest Urgent Care Facility and Emergency Room shall be prominently displayed by all telephones along with contact information for the local ambulance provider.

D. The Contractor shall develop and maintain a Construction Safety Plan as stipulated in Section 01330.

3.12 CONTRACTOR'S PERSONNEL PROTECTION

A. The Contractor is warned that sewage may contain infectious bacteria, viruses and other disease bearing organisms. It is the Contractor's responsibility to urge his personnel to observe a strict regimen of proper hygienic precautions, including any inoculations recommended by the public health officer.

B. Because of the danger of solvents, gasoline and other hazardous materials being carried in raw sewage, sewer lines and manholes are considered hazardous to open flame, sparks or unventilated occupancy. The Contractor shall be aware of these dangers and shall take the necessary measures to assure his personnel observe proper safety precautions when working in these areas.

3.13 TRENCH SAFETY

A. Attention is directed to the provisions of Section 6705 of the Labor Code of the State of California.

B. Excavation for any trench 5 feet or more in depth shall not begin until the Contractor has submitted to the Engineer, with the resolution of "No exceptions taken" of the Contractor's detailed plan for worker protection from the hazards of caving ground during the excavation of such trench. Such plan shall be submitted in accordance with Section 01300 and shall show the details of the design of shoring, bracing, sloping, or other provisions to be made for worker protection during such excavation. No such plans shall allow the use of shoring, sloping or a protective system less effective than that required by the Construction Safety Orders of the Division of Industrial Safety and if such plan varies from the shoring system standards established by the Construction Safety Orders, the plan shall be prepared and signed by an Engineer who is registered as a Civil or Structural Engineer in the State of California.

C. In addition, the Contractor shall obtain, pay for, and comply with all provisions of the permit required by Section 6500 of the California Occupational Safety and Health Act of 1973. A copy of the permit must be submitted per Section 01300.

D. In accordance with the provisions of Section 6707 of the State Labor Code, each bidder shall list, in the Bid Items indicated, the amount contained in his proposal for adequate trench and excavation, sheeting, shoring, and bracing or equivalent method for the protection of life and limb which shall conform to applicable Safety

Orders. By listing this sum in his proposal, the bidder warrants that his action does not convey tort liability to the Owner, the Owner's employees, or the Engineer.

END OF SECTION

SECTION 01020

MODIFICATION OF EXISTING FACILITIES AND ORDER OF WORK

PART 1: GENERAL

1.01 SCOPE

This section covers the care of and work to be done on the Will S Green Avenue Pump Station Project and other requirements affecting the sequence of construction.

The Order of Work contained herein specifies required sequencing and/or timing of construction activities.

1.02 GENERAL CONSTRAINTS ON SEQUENCE AND SCHEDULING OF WORK

A. Conduct work in a manner that will not impair the operational capabilities of essential elements of the wastewater treatment plant.

B. Work sequence and constraints:

1. Gather and submit long lead time items.
2. Sequence construction to coordinate connection to piping by Others in Will S. Green Road right-of-way.
3. Order of work and constraints presented do not include all items affecting completion of the Work, but are intended to describe critical events necessary to minimize disruption of the existing facilities, and complete the work in the allotted contract time.

PART 2: PRODUCTS

2.01 MATERIALS

See Divisions 2 through 17 for materials required.

PART 3: EXECUTION

3.01 INTERFERENCE WITH EXISTING LINES

A. The Contractor shall be responsible for the care and protection of all existing water pipe, sewer pipe, gas mains, culverts, or other facilities and structures that may be encountered in or near the area of the work. In the event of damage to any existing facilities during the progress of the work and of the failure of the Contractor to exercise the proper precautions, the Contractor will pay for the cost of all repairs and protection to said facilities. The Contractor's work may be stopped until repair operations are complete.

B. The Contractor will be required to relocate or replace any pipelines, electric conduits, or other facilities which must be disturbed for new construction work and which are required for facility operation, or make other arrangements satisfactory to the Engineer. Such relocation and replacement may be of temporary type, to be used until work is completed.

In the event of accidental damage to existing lines resulting in interruption of service to yard or building lighting circuits or to any other facility which may be needed for use by the Owner prior to the Contractor's next regularly scheduled work period, the Contractor shall repair to the satisfaction of the Engineer such lines prior to stopping work on the day of such damage.

C. Connections to Existing Facilities: The Contractor shall initiate a request for a connection to existing facilities on the form provided by the Owner. The Contractor shall submit a form a minimum of three (3) business days before the requested connection. Connections shall be scheduled only on Tuesdays through Thursdays. Connection requests that interrupt service to more than ten (10) customers shall be submitted not less than five (5) business days before the connection date. Connections will not be approved for days immediately before or after a holiday.

The operation of any existing Owner valve or other facility shall be by District personnel only.

The Contractor shall be fully prepared to complete the connection in the time allotted and shall not stop work until the facilities are restored to service or until directed to do so by the Owner. All possible preparatory work shall be completed to the satisfaction of the Owner prior to a connection.

3.02 ABANDONMENT OF EXISTING FACILITIES (NOT USED)

A. Pipelines: Pipelines are to be abandoned by either plugging or crimping the ends (for 2-in and smaller pipes) or filling the entire pipeline with pumped flowable cement slurry (for pipes larger than 2 in). Pipeline shall be securely closed at all pipe ends by an approved cap or, at manhole entries, by a watertight plug of concrete or brick and cement mortar, not less than 2 feet thick.

B. Structures: Structures, such as manholes and vaults, shall have all openings, inlets, and outlets sealed off; and the structure shall be removed to a point at least three (3) feet below the proposed street grade or ground surface and filled. When structure is within the County right-of- way, all backfill material shall be compacted Class 2 Aggregate Base. Structures not located in County right-of-way may be backfilled with native material as approved by the District and the surface restored to the surrounding conditions. Seeding and erosion control may also be required for the restored areas.

3.03 DEWATERING AND CLEANING OF STRUCTURES AND PIPELINES

A. The Contractor will dewater structures and pipelines through existing infrastructure, portable pumps or a vacuum “Vactor” truck. It will be the Contractor's responsibility to provide necessary pumps, piping, and other equipment to complete the cleaning and drainage of the structures and pipelines. Dewatering operations shall be conducted in close coordination with District operations staff; no discharges to drainage courses will be permitted.

B. All flushing and cleaning of dewatered structures shall be done by the Contractor in a manner satisfactory to the Engineer. In all cases the Contractor shall conform with OSHA requirements for work in confined spaces, including the provision of adequate ventilation.

3.04 ORDER OF WORK

A. General: The work shall be accomplished in an order that will allow the completion of all improvements shown on the Plans, the Specifications, and the Contract Documents within **365 working days** after the commencement date stated in the Notice to Proceed.

B. Order of work subject to change by the Engineer. If modifications are necessary they may be requested in writing for approval of the Engineer.

C. Coordinate and provide submittals for long lead time items within the first **forty-five (45) working days** after the Notice to Proceed. Long lead time items include but are not limited the following:

1. Precast Concrete Building
2. Precast Concrete Manholes
3. Submersible Sewage Pumps
4. Backup Generator
5. Electrical Control Panels and MCCs

D. Construction and operational constraints for major components of the Project are as follows:

1. Groundwater elevation can vary with season and local irrigation practices.
2. Coordination with PG&E for new electric service.

END OF SECTION

Section 01050

SURVEY CONTROL

PART 1: GENERAL

1.01 DESCRIPTION

This section describes the survey information that the Owner will provide to the Contractor.

1.02 SURVEY CONTROL INFORMATION PROVIDED BY OWNER

The Owner will provide one set of the construction survey controls as indicated on the general site plan at no charge to the Contractor.

1.03 SURVEY CONTROL PROVIDED BY CONTRACTOR

All survey control necessary to complete the work to the lines and grades shown in the contract documents, other than provided for in Section 1.02, shall be provided by the Contractor at no additional cost to the Owner.

1.04 TOLERANCES FOR CONTRACTOR' S MEASUREMENTS

A. The Contractor's measurements for all stakes, marks, or points set for line, grade, or distance shall be to the nearest 1/100 foot and shall not deviate by more than 2/100 foot from the control line, grade, or distance except as follows:

1. Slope stakes for rough excavation may be set to the nearest 1/10 foot;

2. Trench subgrade shall be established to within 1/10 foot above plan subgrade. The use of a grade pole to establish trench subgrade will be permitted; and

3. Pipe subgrade and joint stakes shall be set to within 2/100 foot of plan subgrade and joint station. Use conventional survey instruments and techniques whenever this degree of accuracy cannot be obtained by use of a grade pole.

The Contractor's measurements of lines, grades, and distances will be subject to checking by the Owner's Representative. The Contractor shall correct immediately any such measurements which do not comply with the above tolerances.

PART 2: MATERIALS

Not Used.

PART 3: EXECUTION

3.01 DESCRIPTION

The Contractor is responsible for protecting and maintaining all survey control on the project at no additional cost to the Owner.

END OF SECTION

SECTION 01200

PAYMENT PROCEDURES

PART 1: GENERAL

1.01 SUMMARY

A. Section Includes: Procedures for submitting applications for payment and means used as a basis for Progress Payments, including:

1. Cost Summaries.
2. Payment for Mobilization.
3. Start-up.
4. Demobilization.

B. Related Sections:

Section 01320 - Schedule of Values.

1.02 BASIS FOR PROGRESS PAYMENTS

A. Base Application for Payment on the breakdown of costs for each scheduled activity in the Progress Schedule and the Percentage of Completion for each activity.

B. Generate Application for Payment by downloading cost data from the Progress Schedule to a spreadsheet type format. Identify each activity on the Progress Schedule that has a cost associated with it, the cost of each activity, the estimated Percent Complete for each activity, and the Value of Work Completed for both the payment period and job to date.

1.03 COST SUMMARIES

A. Prepare Summary of Cost Information for each subcategory of each Major Item of Work listed in the Schedule of Values. Identify the Value of Work Completed for both the payment period and job to date.

B. Cash Flow Summary: Prepare cash flow summary, indicating total dollar amount of work planned for each month of the project. Equate sum of monthly amounts to Lump Sum contract price.

1.04 PAYMENT FOR MOBILIZATION

A. Limit amounts included under Mobilization to the following items:

1. Moving on the site any equipment required for first month operations.

2. Installing temporary construction power and wiring.

3. Establishing fire protection plan and safety program.

4. Developing construction water supply.

5. Providing field office trailers for the CONTRACTOR and the ENGINEER, complete with all specified furnishings and utility services.

6. Providing on-site sanitary facilities and potable water facilities as specified.

7. Arranging for and erection of CONTRACTOR's work and storage yard.

8. Submit all required insurance Certificates and bonds.

9. Obtaining all required permits, licenses, and fees.

10. Developing construction schedule.

11. Submit preliminary schedule of values of the Work.

12. Provide and erect the project sign.

13. Post all OSHA, (state agency), Department of Labor, and all other required notices.

14. Location and flagging of construction and clearing.

15. Have CONTRACTOR’s project manager and/or general superintendent on job site full-time.

B. Furnish data and documentation to substantiate the amounts claimed under mobilization.

C. Limit price for mobilization to no more than 5 percent of the Contract Price.

D. No payment for mobilization, or any part thereof, will be recommended until all mobilization items listed above have been completed.

1.05 PAYMENT FOR START-UP TESTING AND DEMOBILIZATION

Prices for start-up and demobilization must total at least 1.5 percent of the Contract Price.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1: GENERAL

1.01 DESCRIPTION

Submittals covered by these requirements include manufacturers' information, shop drawings, test procedures, test results, samples, and requests for substitutions, trench safety plan and miscellaneous work-related submittals. Submittals shall also include, but not be limited to, all mechanical, electrical and electronic equipment and systems, materials, reinforcing steel, fabricated items, detailed piping layout drawings, and conduit details. The Contractor shall furnish all drawings, specifications, descriptive data, certificates, samples, tests, methods, schedules, and manufacturer's installation and other instructions as specifically required in the contract documents to demonstrate fully that the materials and equipment to be furnished and the methods of work comply with the provisions and intent of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01310: Construction Schedule

B. Section 01320: Schedule of Values

1.03 SUBMITTAL PROCEDURE

A. The Contractor shall prepare and submit to the Owner within two weeks after the date of the Preconstruction Conference a complete list of shop drawings and material submittals intended to be delivered. No payment will be made to the Contractor until this list is reviewed and found acceptable to the Owner and the Resident Engineer.

B. At least 30 days prior to his/her need for approval, the Contractor shall forward to the Engineer all submittals required by the individual sections of the specifications. Unless a different number is called for in the individual sections, submit an electronic and one hard copy of each shop drawing, two copies of all operation and maintenance manuals, and two specimens of each sample requested. An electronic copy of each submittal will be returned to the Contractor, except all sample specimens will be retained by the Engineer.

C. The Contractor shall identify all submittals including schedules and operation and maintenance manuals on the transmittal form as included in this Section. Submittals must include submittal number, specification section, plan page reference number (where applicable), the supplier, etc. The Contractor shall also indicate under "Remarks", if the submittal is on the critical path and requires an expedited review. If the Contractor desires more than two copies, he/she shall transfer the Engineer's

comments onto additional copies at his/her own expense.

D. Submittals that are related to or affect each other shall be forwarded simultaneously as a package to facilitate coordinated review. Uncoordinated submittals will be rejected. Do not combine unrelated materials in the same submittal.

E. The Engineer reserves the right to require submittals in addition to those called for in individual sections.

F. The Contractor shall schedule submittals to avoid concentration of submittals in a short time period. Scheduling of submittals shall be included in the Contractor's Progress Schedule.

G. If the Contractor submits shop drawings of equipment by manufacturers other than those listed in the specifications, he/she shall provide the following information with the submittal:

1. The name and address of at least three companies or agencies who are currently using the equipment.

2. The name and telephone number of at least one person at each of the above companies or agencies whom the Engineer may contact.

3. A description of the equipment that was installed at the above locations. The description shall be in sufficient detail to allow the Engineer to compare it with the equipment that is proposed to be installed in this project.

4. Refer to Engineer’s approval (1.05, Part C).

H. A copy of the specification section, and all referenced and applicable sections, with any addendum updates included, shall be submitted with each paragraph check-marked to indicated specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy for the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1. When the Contractor elects to incorporate material included on the Owner's "Approved Materials List" a complete product submittal will not be

required. Instead, the Contractor shall submit a Certificate of Compliance from its supplier, certifying that the supplied item is on the Owner's "Approved Materials List.". Owner review of any submittal shall not relieve the Contractor of responsibility to comply with all requirements of the "Released for Construction" plans and Owner standards. Owner review shall be only for conformance with the plans of the project and for compliance with the information given in the plans and shall not extend to means, methods, sequences, techniques, or procedures of construction, safety precautions or programs incident thereto. The review of a component as such will not indicate acceptance of the assembly in which the item functions. The Contractor will be responsible for coordination of assemblies consisting of separate components.

1.04 SHOP DRAWINGS

A. The term "shop drawings" includes drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials furnished by the Contractor to explain in detail specific portions of the work required by the Contract.

B. The Contractor shall coordinate all such drawings, and review them for legibility, accuracy, completeness, and compliance with contract requirements, and shall indicate his/her approval thereon as evidence of such coordination and review. Shop drawings submitted to the Engineer without evidence of the Contractor's approval will be returned for resubmission.

C. Approval by the Engineer shall not relieve the Contractor from responsibility for any errors or omissions in such drawings, nor from responsibility for complying with requirements of this Contract, except with respect to variations described and approved in accordance with Paragraph D below.

D. If shop drawings show variations from contract requirements, the Contractor shall describe such variations in writing, separate from the drawings, at time of submission. All such variations must be approved by the Engineer.

1.05 ENGINEER'S APPROVAL

A. The Engineer will indicate his/her acceptance or disapproval of each submittal, and his/her reasons for disapproval.

1. If no corrections are required, the copies will be returned marked "NO EXCEPTIONS TAKEN" and work may begin immediately on incorporating the material and equipment covered by the submittal into the project.

2. If limited corrections are required, the copies will be returned marked

"MAKE CORRECTIONS NOTED". Work may begin immediately on incorporating the material and equipment covered by the corrected submittal into the project.

3. If insufficient or incorrect data has been submitted, the copies will be returned marked "AMEND & RESUBMIT". No work incorporating the material and equipment covered by this submittal into the project may begin until the submittal has been revised, resubmitted, and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".

4. If the submittal is unacceptable, the copies will be returned marked "REJECTED - SEE REMARKS". No work incorporating the material and equipment covered by this submittal into the project may begin until a new submittal has been made and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".

B. The Contractor shall not change any drawing after it has been marked NO EXCEPTIONS TAKEN or MAKE CORRECTIONS NOTED or change any approved equipment or material without written permission of the Engineer. The Contractor shall comply with all submittals as marked by the Engineer, to the extent applicable.

C. If more than TWO submittals for a single item are required because of incorrect or insufficient data, or the submittal is unacceptable, or because the Contractor wishes to change previously approved material, then all costs incurred by the Owner for the additional review shall be deducted from monies due the Contractor.

1.06 OPERATION AND MAINTENANCE MANUALS

Manufacturer's printed instructions shall include installation instructions, operating instructions, schematics for electrical and hydraulic systems, maintenance literature, lubrication requirements, and parts lists. Refer to Section 01010, paragraph 3.10 for specifics required for the operation and maintenance instructions.

1.07 CERTIFICATES

For those items called for in individual sections, furnish certificates from manufacturers, suppliers, or others certifying that materials or equipment being furnished under the Contract comply with the requirements of these specifications.

1.08 SAMPLES

Samples shall be of sufficient size to clearly illustrate functional characteristics and full range of color, texture, and pattern. A completed submittal review transmittal form must accompany each submitted sample.

1.09 CONSTRUCTION SCHEDULE

As soon as possible after receiving Notice of Award and before any work starts, submit a Construction Schedule in accordance with Section 01310 showing estimated starting and completion dates for each part of the work. The first progress payment will not be issued until the progress schedule is submitted and approved.

1.10 SCHEDULE OF VALUES

Submit a schedule of dollar values in accordance with Section 01320 for the various portions of the work. The schedule shall be based on the Contract Bid Schedule or Bid Form and shall include all bid items. The schedule of values in conjunction with the construction schedule will be the basis of the monthly progress payments.

1.11 REVIEW OF SCHEDULES

Submit Schedule of Values and Construction Schedule as a package. Both the Progress Schedule and the Schedule of Values shall be subject to review by Engineer both for format and content.

1.12 WEB BASED PROJECT MANAGEMENT SOFTWARE

The project team will use and maintain a web-based database as the primary means of communication related to the Project's correspondence, submittals, requests for information (RFIs), advisory notices, and non-compliance issues. Correspondence from the Contractor shall be sent to the Construction Manager via the web-based project management software system, which shall be identified by the Construction Manager during the project pre-construction meeting.

The Construction Manager and Contractor shall utilize the web-based project management software system for electronic submittal of all data and documents (unless specified otherwise by the Construction Manager) throughout the duration of the Contract. The software will be made available to all Contractor's project personnel. The joint use of this system is to facilitate; electronic exchange of information, automation of key processes, and overall management of the Contract. The software system shall be the primary means of project information submission and management. When required by the Construction Manager, paper documents will also be required. In the event of discrepancy between the electronic version and paper documents, the paper documents will govern.

PART 2: MATERIALS

Not Used.

PART 3: EXECUTION

3.01 CONTRACTOR'S JOBSITE DRAWINGS

Provide and maintain on the jobsite one complete set of full-size prints of all drawings which form a part of the contract. Immediately after each portion of the work is installed, indicate all deviations from the original design shown on the drawings either by additional sketches or ink thereon. Upon completion of the project, deliver this record set to the Owner's Representative.

A condition of the processing of Progress Payments shall be the satisfactory maintenance of the Contractor's Record Documents, as determined by the Engineer. The Contractor prepared progress payment estimates shall include an initial block for Contractor Representative and Owner's Representative to acknowledge the satisfactory maintenance of the documents.

3.02 SUBMITTALS

The Contractor is required to provide submittals for all materials and equipment furnished on the project and applicable contract provisions.

END OF SECTION

SECTION 01305

PROJECT MEETINGS

PART 1: GENERAL

1.01 SUMMARY

A. Conferences and meetings shall be conducted for the purposes of addressing issues related to the Work, reviewing and coordinating the progress of the Work and other matters of common interest, and includes the following:

1. Preconstruction Conference.

2. Progress Meetings.

3. Pre-installation Meetings.

4. Post Construction Meeting.

5. Change Order Meetings.

B. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. At the direction of the City, some progress and other meetings may be conducted online via Microsoft Teams by staff working remotely in coordination with City and Contractors staff working in the field. Contractor should have a laptop computer or tablet with a working internet/WiFi connection or as a minimum, a working cell phone that can be used to join virtual meeting if desired by the City.

1.02 PRECONSTRUCTION CONFERENCE

A. Within 20 days after the Contract Time starts to run, but before any Work at the site is started, a conference attended by CONTRACTOR, ENGINEER, and others as appropriate will be held to establish a working understanding among the parties as to the Work, and to discuss the project schedule, procedures for handling shop drawings and other submittals, processing Applications for Payment, and maintaining required records.

B. The Preconstruction conference agenda will include:

1. Distribution of Contract Documents.

2. Distribution and discussion of list of major subcontractors and suppliers.

3. Proposed progress schedules and critical construction sequencing.

4. Major equipment deliveries and priorities.

5. Project coordination.

6. Designation of responsible personnel.

7. Procedures and Processing of:

   a. Field decisions.

   b. Proposal requests.

   c. Submittals.

   d. Change Orders.

   e. Applications for Payment.

   f. Record Documents.

8. Use of Premises:

   a. Office, construction, and storage areas.

   b. OWNER's requirements.

9. Construction facilities, controls, and construction aids.

10. Shoring requirements and submittal of CONTRACTOR’s geotechnical report.

11. Temporary utilities.

12. Safety and first aid procedures.

13. Security procedures.

14. Housekeeping procedures.

C. The Engineer will record minutes of meeting and distribute copies of minutes within 7 days of the meeting to participants and interested parties.

1.03 PROGRESS MEETINGS

A. Regular progress meetings shall be conducted at least once every two weeks in the Contractor’s or Engineer’s field office or other mutually agreed upon place.

B. Written notice and the proposed agenda shall be distributed to each anticipated

participant of each meeting at least 2 days before meeting.

C. The Contractor's superintendent and subcontractors who are or are proximate to be actively involved in the Work, or who are necessary to agenda shall attend.

D. The Owner, Engineer, other Owner's Representatives, representation of the Agency, and others necessary to agenda will attend.

E. The Contractor shall complete and bring the current Application for Payment and Progress Schedule to each meeting.

F. The Resident Engineer shall preside at meetings.

G. The purpose of Progress Meetings is to:

1. Expedite work of subcontractors or other organizations that are not meeting scheduled progress, resolve conflicts, and coordinate and expedite execution of the Work.

2. Review progress of the Work, Progress Schedule, narrative report, Application for Payment, record documents, and additional items of current interest that are pertinent to execution of the Work.

3. Verify:

a. Actual start and finish dates of completed activities since last progress meeting.

b. Durations and progress of activities not completed.

c. Reason, time, and cost data for Change Order Work that will be incorporated into Progress Schedule and application for payment.

d. Percentage completion of items on Application for Payment.

e. Reasons for required revisions to Progress Schedule and their effect on Contract Time and Contract Price.

4. Discuss potential problems which may impede scheduled progress and corrective measures.

H. Engineer will record minutes of meeting and distribute copies of minutes within 7 days of meeting to participants and interested parties.

1.04 PRE-INSTALLATION MEETINGS

A. General: The Contractor shall meet with manufacturers and installers of major units

of construction which require coordination between subcontractors. Major units of construction which require pre-installation meetings will be identified at the Progress Meetings but should include:

1. Pump Equipment
2. Electrical/Control Pedestals and Panels
3. Other units as directed by ENGINEER.

B. Meeting Requirements: The Contractor shall:

1. Require attendance of Superintendent, appropriate manufacturers and installers of major units of constructions, and affected subcontractors.
2. Invite Owner, Engineer, and Agency.
3. Preside at meetings.
4. Conduct meetings in CONTRACTOR's field office or other mutually agreed upon place.
5. Distribute to each anticipated participant written notice and agenda of each meeting at least 4 days before meeting.
6. Schedule meeting at least 7 days in advance of installation.
7. Record minutes of meeting and distribute copies of minutes within 1 week of meeting to participants and interested parties.

1.05 PROCESS AND SYSTEM SHUTDOWN MEETINGS

A. Conduct meeting at least five (5) days prior to each requested process or system shutdown submitted per Section 01020.

B. Meetings shall be held in CONTRACTOR’s field office, ENGINEER’s field office, or other mutually agreed upon place.

C. CONTRACTOR will distribute to each anticipated participant written notice and agenda of each meeting at least three (3) days before meeting.

D. Required attendance: OWNER, ENGINEER, CONTRACTOR’s superintendent, and all key operations and construction staff necessary to perform the required shutdown.

E. Purpose of Meeting:

1. Review shutdown procedure and schedule with OWNER and ENGINEER.

2. Confirm that all necessary equipment, parts, tools, and other required items will be available for the shutdown.

3. Discuss potential problems that may impact ability to perform shutdown as planned.

4. Review emergency and backup plan procedures.

1.06 POST CONSTRUCTION MEETING

A. General: The Contractor shall meet with and inspect the Work 11 months after date of Substantial Completion with Owner, Engineer, and Agency.

B. Meeting Requirements: The Contractor shall:

1. Arrange meeting at least 14 days before meeting.

2. Meet in Owner's office or other mutually agreed upon place.

3. Inspect the Work and draft list of items to be completed or corrected.

4. Require attendance of Superintendent, appropriate manufacturers and installers of major units of constructions, and affected subcontractors.

5. Review service and maintenance contracts, and follow-up with appropriate corrective action when necessary.

6. After meetings, complete or correct defective work and extend correction period accordingly.

1.07 CHANGE ORDER MEETINGS

A. Periodic meetings will be held as needed for the purpose of agreeing on change order costs, reviewing quotation requests, and for reviewing time and expense records if necessary.

B. The Resident Engineer shall preside at meetings.

C. The Contractor, Owner, Engineer, other Owner's Representatives, Representatives of the Agency, and other necessary shall attend.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULE

PART 1: GENERAL

1.01 DESCRIPTION

This section specifies the procedures for preparing and revising the cost-loaded critical path construction schedule used for planning and managing construction activities. The schedule provides a basis for determining the progress status of the project relative to the completion time, specific dates, and for determining the acceptability of the Contractor's progress payment estimates. No progress payments will be made until the Engineer and Owner's Representative have accepted the Contractor's construction schedule and schedule of values.

PART 2: MATERIALS (NOT USED)

PART 3: EXECUTION

3.01 DESCRIPTION

A. The Contractor shall prepare a time scale network schedule using a critical path method. The critical path schedule shall be prepared from estimates of the required duration and sequence for each item of work and function to be performed. A general guide for preparing such a schedule is contained in "Construction Planning and Scheduling Manual" published by the Associated General Contractors of America. Tabulation and analysis of the work schedule shall be performed by computer using a commercially available critical path software program. Contractor to provide one licensed complete set of scheduling software to the Engineer at no additional cost to the Owner/Engineer. In addition to the capability to produce tabular reports, the computer software shall plot the construction schedule after the Contractor has produced it in draft form as required by Paragraph 3.02.

B. The schedule shall depict all significant construction activities and all items of work listed in the breakdown of contract prices submitted by the Contractor in accordance with Submittals, Section 01300-1.10, and Section 01320, Schedule of Values. Assigned values for each part of the work shall be indicated.

The dependencies between activities shall be indicated so that it may be established what effect the progress of any one activity has on the schedule. Any milestone activities identified in specification section 01020 must be indicated. Critical dates for Owner furnished Contractor installed materials shall be indicated showing reasonable delivery periods.

C. Completion time and all specific dates given in Special Provisions shall be shown on the schedule. Activities making up the critical path shall be identified.

D. No activity on the schedule shall have a duration longer than 30 days or assigned value greater than $200,000, except activities comprising only fabrication and delivery may extend for more than 21 days. Activities which exceed these limits shall be divided into more detailed components. The scheduled duration of each activity shall be based on the work being performed during the normal 40-hour work week with allowances made for legal holidays and normal weather conditions.

E. In addition to the overall schedule, the Contractor shall provide a schedule of the first 60 calendar days at the preconstruction meeting, as a condition to receiving the notice to proceed, and a four-week bar chart schedule to be provided weekly after acceptance of the overall schedule.

This 60-day schedule shall use the same activity names as will be used on the base line schedule. This 60-day schedule shall serve as a control document while the overall schedule is in the approval process.

The four-week bar chart schedule shall be provided bi-weekly for review the day prior to the normal scheduled bi-weekly construction meeting. The format shall be one week of history and three weeks of look ahead. It shall be on a work crew level but with schedule activity numbers clearly indicated. It shall be directly produced from the approved project CPM schedule database, not independently from some other data.

3.02 SUBMITTAL PROCEDURES

A. The Contractor shall provide a schedule of the first 60 calendar days of the project at the preconstruction meeting as a condition to receiving the notice to proceed. This 60-day schedule shall be prepared on reproducible paper and may be in draft form with legible freehand line and lettering.

B. Within 20 days after the date of the Notice to Proceed, the Contractor shall complete a construction schedule conforming to paragraph 3.01 and representing in detail all planned procurement and on-site construction activities. Upon completion of the schedule, the Contractor shall submit the original and two copies to the Engineer in accordance with Section 01300. The schedule shall be prepared on reproducible paper.
A computer diskette of the database clearly labeled and dated, shall be provided to the Construction Manager to facilitate analysis by the Engineer and Owner's Representative.

C. Within 14 days after receipt of the submittal, the Engineer and the Owner's Representative shall review the submitted schedule and return one copy of the marked up original to the Contractor. If the Engineer finds that the submitted schedule does not comply with specified requirements, the corrective revisions will

be noted on the submittal copy returned to the Contractor for corrections and re-submittal as specified in Section 01300. Upon receipt of a schedule and breakdown of contract prices conforming to the contract, the Contractor shall submit the final version of the construction schedule and database to the Engineer in accordance with Section 01300.

Within 14 days after the Engineer has accepted the Contractor's construction schedule and values assigned to the activities of the construction schedule, the Contractor shall provide two copies of computer reports to the Engineer. The reports will be on 8-½ -inch by 11-inch sheets as follows:

1. Tabular listing of activities showing early and late start and finish dates.

2. Printout network, clearly showing the critical path.

3. Report on cost and payment status for each activity.

4. Summary of the costs for each facility

5. These reports will serve as the basis for the Contractor's progress payment requests. Acceptance of the Contractor's schedule and furnishing reports to the Engineer shall not relieve the Contractor of his responsibility for the adequacy of the schedule and for managing all construction activities including those of subcontractors and suppliers.

D. After acceptance of the overall construction schedule, the Contractor shall submit the three-week bar chart schedules on a weekly basis.

3.03 SCHEDULE REVISIONS

Revisions to the accepted cost-loaded construction schedule may be made only with written approval of the Engineer and Owner. Changes in timing for activities which are not on the critical path may be modified within the available period of the activities' specific available float but not in a manner which will place them on the critical path, with the written agreement of the Contractor and Engineer. A change affecting the contract value of any activity, the timing of any activity on the critical path, the completion time and specific dates may be made only in accordance with applicable provisions of the Contract Documents.

3.04 PROJECT STATUS UPDATE

Project schedule status and updates electronically shall be provided each month and submitted with the monthly pay request. Monthly progress payments will not be made until the project status reviews have been submitted and accepted by the Engineer. Project status updates shall be submitted to the Engineer in accordance with Section 01300, including a completed submittal review transmittal form.

END OF SECTION

SECTION 01320

SCHEDULE OF VALUES

PART 1: GENERAL

1.01 SUMMARY

This section includes the requirements for the preparation, format, and submittal of Schedule of Values.

1.02 PREPARATION

A. Prepare Schedule of Values identifying costs of major items of Work and other costs shown in example form at end of this Section.

B. Divide the Work into the following major items of Work:

1. Mobilization including bonds and insurance
2. Demobilization
3. Sheeting, Shoring, and Bracing
4. Stormwater Pollution Protection Plan
5. Sitework
6. Cobble on Fabric
7. Paving
8. Sewer Pump Station Construction
9. Recycled Water Booster Pump Station
10. Electrical and Controls
11. Miscellaneous

C. Assign prices to major items of Work that aggregate the Contract Price. Base prices on costs associated with scheduled activities based on the Project Schedule for each major item of Work.

1.03 SUBMITTALS

A. Submit preliminary Schedule of Values for all the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during the performance of Work. Such prices shall include an appropriate amount of

overhead and profit applicable to each item of Work.

B. Submit corrected schedule of values within 10 days upon receipt of reviewed Schedule of Values, but no later than 10 days prior to anticipated submittal of first Application for Payment, in accordance with Contract documents, Section D-9.3.

C. Upon request, support prices with data that will substantiate their correctness.

D. If activities are added or removed from the Construction Schedule revise the Schedule of Values and resubmit.

PART 2: MATERIALS (NOT USED)

PART 3: EXECUTION

3.01 EXAMPLE SCHEDULE OF VALUES

The following is a partial example of an acceptable form for the Schedule of Values using Construction Standards Institute (CSI) Divisions:

SCHEDULE OF VALUES (Sample Only)

Item	Description of Item	Qty	Unit	Unit Cost	Total Cost
6.	Grading and Paving				
a.	Division 01 - General Requirements				
b.	Division 02 - Sitework				
c.	Division 03 – Concrete				
d.	Division 04 – Masonry				
e.	Division 05 – Metals				
f.	Division 06 – Wood and Plastics				
g.	Division 07 – Thermal & Moist. Protect.				
h.	Division 08 – Doors & Windows				
i.	Division 09 – Finishes				
j.	Division 10 - Specialties				
k.	Division 11 - Equipment				
l.	Division 12 – Furnishings				
m.	Division 13 – Special Construction				
n.	Division 14 – Conveying Systems				
o.	Division 15 - Mechanical				
p.	Division 16 - Electrical				
q.	Division 17 - Instrumentation				
	TOTAL FOR THIS ITEM				

END OF SECTION

SECTION 01330

SAFETY PLAN

PART 1: GENERAL

1.01 SUMMARY

Section Includes: Development and maintenance of a Construction Safety Plan.

1.02 REFERENCES

A. Occupational Safety and Health Standards (OSHA).

B. California Labor Code, Section 6401.7.

C. National Fire Protection Association (NFPA):

1. 70E - Standard for Electrical Safety in the Workplace.

1.03 CONSTRUCTION SAFETY PLAN

A. Detail the Methods and Procedures to comply with California Labor Code Section 6401.7, NFPA 70E, California, Federal, and Local Health and Safety Laws, Rules and Requirements for the duration of the Contract Times. Include the following:

1. Identification of the Certified or Licensed Safety Consultant, who will prepare, initiate, maintain, and supervise safety programs, and procedures.

2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered in the course of construction.

3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction. Include warning devices, barricades, safety equipment in public right-of-way and protected areas, and safety equipment used in multi-level structures.

4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.

5. Procedures for reporting safety or health hazards.

6. Procedures to follow to correct a recognized safety and health hazard.

7. Procedures for investigation of accidents, injuries, illnesses and unusual events that have occurred at the construction site.

8. Periodic and scheduled inspections of general work areas and specific work

stations.

9. Training for employees and workers at the jobsite.

10. Methods of communication of safe working conditions, work practices and required personal protection equipment.

B. Assume responsibility for every aspect of Health and Safety on the jobsite, including the health and safety of Subcontractors, suppliers, and other persons on the jobsite.

1. Forward available information and reports to the Safety Consultant who shall make the necessary recommendations concerning worker health and safety at the jobsite.

2. Employ additional health and safety measures specified by the Safety Consultant, as necessary, for workers in accordance with OSHA guidelines.

C. Transmit to OWNER and ENGINEER copies of reports and other documents related to accidents or injuries encountered during construction within ten (10) days of the accident or injury.

D. CONTRACTOR shall maintain MSDS binder for all materials CONTRACTOR is using on site. CONTRACTOR shall transmit a copy of every MSDS to OWNER before use on site.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

SECTION 01340

REQUESTS FOR INFORMATION AND CLARIFICATIONS

PART 1: GENERAL

1.1 DESCRIPTION

A. Should the Contractor discover conflicts, omissions, or errors in the Contract Documents, or have any questions concerning interpretation or clarification of the Contract Documents, or if it appears to the Contractor that work to be done, or any matter relative thereto, are not sufficiently detailed or explained in the Contract Documents, then, before proceeding with the work affected, the Contractor shall immediately notify the Engineer in writing and request interpretation, clarification, or additional detailed instructions concerning the work. The Contractor shall ask for any clarification or request for information immediately upon discovery, but no less than fifteen (15) days prior to the start date of the activities related to the clarification, based on the latest updated and accepted construction schedule. Contractor shall be responsible for its costs to implement and administer RFI's throughout the Contract duration. Regardless of the number of RFI's submitted, Contractor will not be entitled to additional compensation.

B. A RFI is not to be used for request for materials /equipment substitutions or value engineering/cost reduction incentive proposals.

1.2 RFI PROCEDURES

A. Contractor review and submittal:

1. Contractor's review: Before submitting each RFI, the Contractor shall carefully review the following for relevant information:

a. All field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto.

b. All materials with respect to intended use, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work.

c. All information relative to means, methods, techniques, sequences, and procedures of construction and safety precautions and programs incident thereto.

d. The coordination of each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.

e. The Contract Documents.

f. The Project correspondence and documentation.

2. Submittal requests

a. The Contractor shall submit all requests for clarification and/or additional information in writing through the Engineer to the Engineer using a request for information (RFI) form. Contractor shall provide a detailed written statement that indicates the specific Drawings or Specifications in need of clarification and the nature of the clarification requested.

b. Contractor shall upload an electronic version of each RFI. Each RFI shall be dated and bear a signed certification that Contractor has performed the review defined above. No consideration for review by Engineer of any RFI will be made for any item which has not been certified by the Contractor. All non-certified RFI's will be returned to Contractor without action taken by Engineer, and any delays caused thereby shall be the total responsibility of Contractor.

c. Each RFI shall be limited to one subject.

B. RFI numbering system: The Engineer will assign blocks of numbers for the Contractor, Engineer, Owner's Representative, and for substitutions. The Contractor will use the block of numbers consecutively with the date of issue, except for re-issuance of a respective RFI in which the subscript A, B, C, etc., will be added until the RFI is resolved. If Contractor believes the RFI reviewer's response is incomplete, Contractor shall issue another RFI (with the same RFI number with the letter "A" indicating if it is a follow-up RFI) to Engineer clarifying original RFI. Additionally, Engineer may return RFI requesting additional information should original RFI be inadequate in describing condition.

C. Owner's RFI review and response time:

1. Except as may otherwise be provided herein, the Engineer will return one copy of each RFI form to Contractor, with its comments noted thereon or on a separate comment sheet, within a reasonable amount of time, but no more than fifteen (15) calendar days following their receipt from Contractor, or if it is necessary to extend this period, the Engineer shall notify the Contractor in writing as to when a decision will be provided.

2. Engineer's review will be only to provide clarification and interpretation of the Contract Documents. Engineer's review shall not relieve Contractor of the responsibility for compliance with the Contract Documents.

3. Engineer's review will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto.

4. The Engineer may furnish additional detailed written instructions to further explain the work, and such instructions shall be a part of the contract documents. Clarifications will be issued using the above RFI system. Should additional detailed instructions in the opinion of the Contractor constitute work in excess of the scope of the contract, the Contractor shall submit notification immediately and written notification thereof to the Engineer no more than seven (7) days following receipt of such instruction, and in any event prior to the commencement of work thereon. If the Engineer considers it justified, the instructions of the Engineer will be revised or a proposed change order will be issued for the Owner's consideration. The Contractor shall have no claim for additional compensation or extension of the schedule because of any such additional instructions unless the Contractor provides the Engineer written notice thereof within the time frame specified above. In addition, the Contractor shall within fifteen (15) days from the date of notification provide detailed justification and analysis as well as complete pricing and schedule CPM fragmentary network to support any request for time extension.

5. Should the Contractor proceed with the work affected before receipt of a response from the Engineer, any portion of the work which is not done in accordance with the Owner's interpretation, clarifications, instructions, or decisions subject to removal or replacement and the Contractor shall be responsible for all losses.

6. RFI's will not be recognized or accepted, if in the opinion of the Engineer or Engineer, that one of the following conditions exists:

    a. The Contractor submits an RFI as a submittal.

    b. The Contractor submits the RFI under the pretense of a contract documents discrepancy or omission without thoroughly reviewing the documents. In this case, the Contractor shall be responsible for both the Engineer's and Engineer's administrative costs to process the RFI. Such costs will be deducted from Contractor's progress payments.

c. The Contractor submits the RFI in a manner that suggests that specific portions of the contract documents are assumed to be excluded, or be taken as an isolated portion of the contract documents in part rather than whole.

d. The Contractor submits an RFI in an untimely manner without proper coordination and scheduling of work or related trades.

7. The Engineer's review shall not relieve Contractor from the entire responsibility for any variation from the requirements of the Contract Documents unless Contractor has in writing called attention to each such variation at the time of each RFI submittal and Engineer has given written approval of each such variation by specific written notation thereof incorporated in the RFI review; nor will any review by Engineer relieve Contractor from responsibility for compliance with the requirements for careful review above.

PART 2: MATERIALS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

SECTION 01354

HAZARDOUS MATERIAL PROCEDURES

PART 1: GENERAL

1.01 SUMMARY

Section includes:

1. Procedures required when encountering hazardous materials at the Work site and
2. Covers the handling and use or disposal of hazardous and potentially hazardous excavated materials.

1.02 REFERENCES

A. American Conference of Government Industrial Hygienists (ACGHI).

B. California Health and Safety Code, Section 25117.

C. American National Standards Institute (ANSI).

D. State of California Code of Regulations (CCR):

1. Title 8. Industrial Relations:

2. Title 22. Social Security:

a) Division 4. Environmental Health.

b) Division 4.5. Environmental Health Standards for the Management of Hazardous Waste.

E. National Institute for Occupational Safety and Health (NIOSH).

F. Occupational Safety and Health Administration (OSHA)

G. Society for Protective Coatings (SPCC):

1. Guide 6 - Guide for Containing Debris Generated During Paint Removal Operations.

2. Guide 7 - Guide for the Disposal of Lead-Contamination Surface Preparation Debris.

H. United States Environmental Protection Agency (EPA).

I. United States Code of Federal Regulation (CFR):

1. Title 29 – Labor:

   a) 1926.62 – Lead

   b) Part 19, Occupational Safety and Health Standards

   c) Subpart H, Hazardous Materials

   d) Section 120, Hazardous Waste Operations and Emergency Response

2. Title 40 - Protection of Environment

   a) 261 - Identification And Listing Of Hazardous Waste

1.03 CERTIFICATION REQUIREMENTS

The CONTRACTOR or the subcontractor responsible for excavation shall be certified by the State of California for hazardous substance removal. The license number of the certified contractor shall be indicated in the bid proposal.

1.04 TRAINING REQUIREMENTS

Personnel responsible for excavation shall be trained in accordance with 29 CFR Part 19, Occupational Safety and Health Standards, Subpart H, Hazardous Materials, Section 120, Hazardous Waste Operations and Emergency Response.

1.05 SUBMITTALS

A. Submit laboratory reports, hazardous material removal plans, and certifications.

B. Prior to beginning any excavation, submit the following:

1. Documentation showing that the excavation contractor is trained as required herein.

2. A list of personnel who will be responsible for implementation any Health and Safety Plan, if required, and their roles

1.06 HAZARDOUS MATERIALS PROCEDURES

A. Hazardous materials are those defined by 40 CFR and California Health and Safety Code, Section 25117.

B. When hazardous materials have been found that are identified on plans of the Contract documents:

1. Prepare and initiate implementation of plan of action.

2. Notify immediately OWNER, ENGINEER, and other affected persons.

3. Notify such agencies as are required to be notified by Laws and Regulations with the times stipulated by such Laws and Regulations.

4. Designate a Certified Industrial Hygienist to issue pertinent instructions and recommendations for protection of workers and other affected persons' health and safety

5. Identify and contact subcontractors and licensed personnel qualified to undertake storage, removal, transportation, disposal, and other remedial work required by, and in accordance with, laws and regulations.

C. When hazardous materials have been found that are not identified on the Contract Documents.

1. Prepare and initiate implementation of plan of action.

2. Notify immediately OWNER, ENGINEER, and other affected persons.

3. Notify such agencies as are required to be notified by Laws and Regulations with the times stipulated by such Laws and Regulations.

4. Designate a Certified Industrial Hygienist to issue pertinent instructions and recommendations for protection of workers and other affected persons' health and safety.

5. Identify and contact subcontractors and licensed personnel qualified to undertake storage, removal, transportation, disposal, and other remedial work required by, and in accordance with, laws and regulations.

D. Forward to ENGINEER, copies of reports, permits, receipts, and other documentation related to remedial work.

E. Assume responsibility for worker health and safety, including health and safety of subcontractors and their workers.

1. Instruct workers on recognition and reporting of materials that may be hazardous.

F. File requests for adjustments to Contract Times and Contract Price due to the finding of Hazardous Materials in the Work site in accordance with Contract Documents.

1. Minimize delays by continuing performance of the Work in areas not affected by hazardous materials operations.

1.07 INDEMNIFICATION

The District will indemnify, hold harmless, and defend the Contractor from all suits, actions, damages, or claims resulting from hazardous materials placed by the Contractor within the site of the wastewater treatment plant in accordance with contract requirements. This clause shall protect the Contractor only to the extent that said suits, actions, damages, or claims are based solely on the propriety of retaining said hazardous materials on-site.

1.08 ASBESTOS MATERIALS

A. It is the specific intent of these Contract Documents to exclude from the Work any and all products or materials containing asbestos. No products containing asbestos shall be incorporated in the Work.

B. Removal of existing ACM shall be performed by a firm that is registered by Cal-OSHA and certified by the State Contractors Licensing Board and shall be a Licensed Abatement Contractor in the state where the project is located.

C. Submit 10 copies of plan for the removal, containment, and disposal of ACM.

D. Submit 6 copies of abatement license of ACM removal contractor

E. The CONTRACTOR shall be responsible for the proper removal and disposal of asbestos material.

1.09 PERMITS AND FEES

A. CONTRACTOR shall be responsible for obtaining and paying for all permits and fees required for completion of the Work.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 GENERAL

A. The District shall provide a Soil Engineer to observe excavation work. The Soil Engineer shall classify excavated materials according to the following classifications:

1. Native Nonhazardous: This classification shall apply to soil and rock excavations that are judged by the Soil Engineer to consist of native materials, not subject to possible hazardous materials contamination.

a) Not suitable for fill – dispose of at designated site

b) Suitable for random fill – stockpile for use

c) Suitable for structural backfill – stockpile for use

2. Potentially Hazardous: This classification shall apply to Materials identified by the Soil Engineer. The Soils Engineer may further classify this material by type.

B. After soil is classified by the Soil Engineer, the Contractor shall handle the soil as specified herein.

C. All materials used for on-site fill shall be subject to the requirements of Sections 02210, 02221, and 02225, as applicable.

3.02 TESTING OF MATERIALS

A. The District shall obtain composite samples of the stockpiled material and shall analyze the samples to determine actual levels of contamination and verify that disposal in a Class I landfill without further treatment is acceptable. The Contractor shall be responsible to maintain the stockpile for up to 30 days after the last material is placed in the stockpile, during which time the sampling and analyses shall be completed and results provided to the Contractor.

B. If the material is determined to be neither hazardous nor a designated waste (as defined by the State of California), the material will be reclassified as Native Nonhazardous material and shall be handled in accordance with the applicable requirements for such material. If the material is determined to be either a hazardous or designated waste, the Contractor shall dispose of the material in a Class I or Class II land fill as determined by the District.

C. Contractor shall use analytical data provided by the District to prepare all regulatory paperwork for acceptance to the disposal facility, including:

1. Waste profiles,

2. Land Disposal Restriction Notifications, if necessary, and

3. Hazardous Waste Manifests or other shipping papers.

D. Contractor shall provide copies of all regulatory paperwork to the District.

E. The Contractor shall load, transport, and dispose all stockpiled Hazardous soil.

1. The Contractor shall use trucks licensed as hazardous waste haulers.

2. The Contractor shall bear all costs involved with this work, including loading, trucking, profile fees, disposal fees, and any county hazardous waste disposal taxes. Contractor shall not be responsible for California State Board of Equalization mandated hazardous waste disposal taxes.

3.03 SEGREGATION OF MATERIALS

A. The Contractor shall segregate all excavated materials according to the classifications assigned by the Soil Engineer.

3.04 STOCKPILING OF POTENTIALLY HAZARDOUS MATERIALS

A. Until use or disposal, stockpile in an area where drainage water flows away from the stockpile and protect the stockpile from water infiltration and erosion during wet weather.

B. Until use or disposal, stockpile on and cover with 10 mil high density polyethylene (HDPE).

C. Use sand bags or other suitable weights to hold cover in place.

3.05 ALLOWED USES OR DISPOSAL

A. The Contractor may export suitable Native Nonhazardous materials from the site or use on-site for required fill.

3.06 PAYMENT

1. The Agency shall reimburse disposal costs to the contractor, if encountered.

END OF SECTION

Section 01410

REGULATORY REQUIREMENTS

PART 1: GENERAL

1.01 SUMMARY

A. Section includes: Regulatory requirements:

1. Building code.
2. Electrical code.
3. Energy code.
4. Fire code.
5. Mechanical code.
6. Plumbing code.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code, 2011.

B. California Code of Regulations (CCR),

1. Title 24: California Building Standards Code.

a. California Building Code -2010 (CBC). (Title 24, Part 2.)
b. California Electrical Code -2010 (CEC). (Title 24, Part 3.)
c. California Mechanical Code -2010 (CMC). (Title 24, Part 4.)
d. California Plumbing Code -2010 (CPC). (Title 24, Part 5.)
e. California Energy Code -2010 (CEC). (Title 24, Part 6.)
f. California Fire Code -2010 (CFC). (Title 24, Part 9.)
g. California Green Building Standards Code -2010 (Cal Green). (Title 24, Part 11.)

1.03 SYSTEM DESCRIPTION

A. Design requirements::

1. Building code:

   a. California Building Code.

   b. California Green Building Standards Code.

2. Electrical code:

   a. California Building Code.

3. Energy conservation code:

   a. California Energy Code

4. Fire code:

   a. California Fire Code.

5. Mechanical codes.

   a. California Mechanical Code.

6. Plumbing code:

   a. California Plumbing Code.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1: GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, and removal after construction**.**

1.02 REFERENCES

B. Occupational Safety and Health Standards (OSHA).

C. California Labor Code, Section 6401.7.

D. National Fire Protection Association (NFPA):

1. 70E - Standard for Electrical Safety in the Workplace.

1.03 SUBMITTALS

A. General: For products specified to be furnished under this Section, submit product data as specified in Section 01300.

B. For temporary piping systems:

1. Submit layout drawings showing proposed routing of piping, including proposed pipe support and pipe restraint locations.
2. Submit product data for piping, fittings, appurtenances, restraints, supports, and all other components of the temporary piping system.

C. For temporary pumping systems:

1. Submit pump data, performance curves, and other operating information as specified in Section 15050.
2. Submit sketches showing layout of temporary pumping system, including pump quantity, configuration in wet well, and proposed piping layout specified in this Section.
3. Methods for minimizing employees' exposure to safety and health hazards expected during construction.

D. Submit all information at least 28 days prior to when the temporary pumping system is scheduled to be installed and allow 14 days for review and comment by Engineer and Owner.

1.04 TEMPORARY UTILITIES

A. Temporary electrical power:

1. The CONTRACTOR is responsible for making all arrangements with the Owner and paying all costs to provide adequate temporary electrical services except for the following where OWNER may allow for temporary connections if available during certain phases of the work.

2. The Contractor is responsible for providing all breakers, switches, transformers, and cables required to obtain temporary power from these location(s).

3. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.

4. Provide, maintain, and pay for electric power for performance of the Work.

B. Temporary electrical lighting:

1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.
2. When available, permanent lighting facilities may be used in lieu of temporary facilities.

C. Temporary heating, cooling, and ventilating:

1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.

D. Temporary water:

1. Pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
2. Remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.
3. Pay for water used for construction prior to Substantial Completion. Owner will provide water for 5-day final test.
4. Development of non-potable water supply:

a. Post ample signs throughout the work area warning that plant water is not potable.
b. Non-potable water is available from hydrants or hose valves within plant without cost. When combined demand of the Work and plant exceeds plant supply capacity, provide additional temporary supply capacity.

E. Temporary sanitary facilities:

1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
2. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

F. Temporary fire protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.

G. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

H. Utilities in existing facilities: As specified in Section 01020.

1.05 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to assure adequate load bearing capability:

1. When requested, submit design calculations by professional registered engineer prior to application of loads.
2. Submitted design calculations are for information and record purposes only.

D. Accident prevention:

1. Exercise precautions throughout construction for protection of persons and property
2. Observe safety provisions of applicable Laws and Regulations.
3. Guard machinery and equipment, and eliminate other hazards.
4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
5. Before commencing construction work, take necessary action to comply

with provisions for safety and accident prevention.

E. Barricades:

1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
2. Provide barriers with flashing lights after dark.
3. Keep barriers in place until excavations are entirely backfilled and compacted.
4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:

1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Hazards in public right-of-way:

1. Mark at reasonable intervals, trenches, and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
    a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
2. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
    a. During hours of darkness, provide warning lights at close intervals.

H. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

I. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

J. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.

K. Fences:

1. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons.
    a. Bear responsibility for protection of plant and material on site of the

Work when openings in existing fences are not closed.

2. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.
3. Fence temporary openings when openings are no longer necessary.

1.06 SECURITY

A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.07 ACCESS ROADS

A. General:

1. Build and maintain access roads to and on site of the Work to provide for delivery of material and for access to existing and operating plant facilities on site.
2. Build and maintain dust free roads which are suitable for travel at 20 miles per hour.

B. Off-site access roads:

1. Build and maintain graded earth roads.
2. Build roads only in public right-of-way or easements obtained by Owner.
3. Obtain rights-of-way or easements when electing to build along other alignment.

C. On-site access roads:

1. Maintain access roads to storage areas and other areas to which frequent access is required.
2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
4. Maintain on-site access roads free of mud. Under no circumstances shall vehicles leaving the site track mud off the site onto the public right-of-way.

1.08 TEMPORARY CONTROLS

A. Dust control:

1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.

B. Noise control:

1. In inhabited areas, particularly residential, perform operations in manner to minimize noise.
2. In residential areas, take special measures to suppress noise during night hours.

C. Mud control

1. Prevent mud nuisance caused by construction operations, unpaved roads excavation, backfilling, demolition, or other activities.

1.09 PROJECT SIGN

A. Provide and maintain Project identification sign consisting of painted 8-foot wide by 4-foot high made of 3/4 inch thick exterior grade plywood or other approved material, 4 by 4 lumber posts, set in ground at least 3 feet, with exhibit lettering by professional sign painter using no more than 5 sign colors:

1. List at least the title of the Project, and names of the Owner, Engineer, and Contractor.
2. Contractor's and Engineer's names shall be identified in upper right hand corner underneath the bid number.

B. Submit Project sign for approval prior to manufacturing sign.

C. Erect Project identification sign where directed by OWNER.

1.10 REMOVAL

A. Remove temporary buildings and furnishings before inspection for Substantial Completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Clean and repair damage caused by installation or use of temporary facilities match surrounding conditions.

D. Restore existing facilities used during construction to specified or original condition.

1.11 TEMPORARY PROCESS PIPING (NOT USED)

A. Contractor shall provide all piping, appurtenances, and other materials as required to provide temporary piping systems as specified in this Section, as indicated on the Drawings, and as needed to perform the Work.

B. Contractor shall field route piping as needed and as field conditions dictate, unless otherwise indicated on the Drawings, and determine appropriate lengths of piping and quantity/type of pipe fittings needed to construct temporary piping system. Do not block access points such as stairs, doors, and walkways to existing facilities unless approved in writing by the Owner.

C. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:

1. When piping is buried, use concrete thrust block or mechanical restraints.
2. When piping is exposed or under water, use mechanical or structural restraints.
3. Determine thrust forces by multiplying the nominal cross sectional area of the piping by the operating pressure of the piping.

D. Temporary piping systems shall be installed in a manner that will not damage existing or new facilities.

E. Unless indicated otherwise, piping material, including gaskets, shall be suitable for the process fluid requiring temporary piping.

F. After temporary piping system is no longer required:

1. Remove temporary piping system.
2. Clean and repair damage caused by installation or use of temporary piping system.
3. Restore existing facilities to original condition.

1.12 TEMPORARY PROCESS PUMPING (NOT USED)

A. Contractor shall provide temporary pumping system, appurtenances, and other materials as required to provide temporary piping systems as specified in this Section, as indicated on the Drawings, and as needed to perform the Work:

1. Anticipated pressure will vary based on head losses developed and the final length of installed temporary piping. Contractor shall calculate head losses and provide pump with sufficient pressure to meet flow requirements. Calculations shall be sealed and signed by a professional engineer registered in the state in which the Project is located.

2. Pump shall be capable of passing a solid with a sphere size of 3 inches.
3. Temporary pumps shall be capable of matching plant flow rates through the use of variable flow rate pumping. The use of cycled pumping (i.e., on/off) is not acceptable. Provide all wiring and controls necessary to match plant flow rate based on 4 to 20 milliamperes signal available at the Operations Building.
4. Provide and pay for all power required to operate temporary pumps.
5. All electrical and instrumentation components will comply with applicable code requirements for the area where the temporary pump is located.
6. Temporary pumping will be required 24 hours per day during the time period when pumping is required and is critical to the proper operation of the Owner's treatment facility. Provide 24-hour on-site supervision of pumps to ensure that pumps are always operational and performing as required. Notify the Owner immediately if temporary pumping cannot be provided.
7. Contractor shall be responsible for repairing any damage or reimbursing the Owner for any regulatory fines or additional plant staff time resulting from the Contractor's failure to maintain temporary pumping.
8. Provide 100 percent backup (a.k.a., standby, redundant, etc.) pumping capacity equal to the required process flow rate. Backup system shall be capable of providing required pumping capacity immediately upon failure of primary pumping system.
9. All necessary spare equipment and appurtenances shall be available on-site to allow immediate repair and/or replacement of any pumping system component that is not functioning properly.

B. Providing temporary piping systems as specified in this Section.

C. Temporary pumping of other process flows is not allowed unless approved in writing by the Owner.

D. Restore existing facilities to original condition.

1. Remove temporary process pumping system.
2. Clean and repair damage caused by installation or use of temporary process pumping system.
3. Restore existing facilities to original condition.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

SECTION 01610

SEISMIC ANCHORAGE AND BRACING

PART 1: GENERAL

1.01 SECTION INCLUDES

A. Requirements for seismic anchorage and bracing for equipment, tanks, pipe, ducts, conduit and other nonstructural components.

1.02 REFERENCED SECTIONS

A. The following Sections are referenced in this Section

1. Section 01300 – Submittals

2. Section 01611 – Seismic Design Requirements

3. Section 05500 – Metal Fabrications

1.03 AREAS OF DESIGN RESPONSIBILITY

A. The Contractor shall be responsible for:

1. Designing seismic attachments, braces, and anchors to the structure for tanks, mechanical equipment and electrical equipment included in the Work that weigh more than 20 pounds.

2. Design of seismic anchorage and bracing for piping systems and ventilation ducting.

B. Equipment manufacturers shall provide design calculations and details for their specific pieces of equipment as part of the submittal for that equipment.

1.04 REFERENCES

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

1. International Code Council (ICC)

2. California Building Code (CBC)

3. Evaluation Service (ICC-ES) Reports and Legacy Reports

4. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Building and Other Structures.

1.05 SUBMITTALS

A. Comply with Section 01300.

B. Seismic Anchorage and Bracing Calculations

1. Submit manufacturer's engineered seismic hardware data and installation requirements.

2. Provide calculations for seismic attachments, braces and anchorages clearly showing the criteria used for the design. Calculations for anchorage of components shall be stamped and sealed by a California registered Civil Engineer.

C. Shop Drawings: Show details of seismic attachment assemblies including connection hardware, bracing, and anchor bolts.

1.06 DESIGN AND PERFORMANCE REQUIREMENTS

A. In accordance with CBC, tanks, mechanical and electrical components, and other elements of the Work that are permanently attached to structures shall be designed and constructed to transfer the component seismic forces specified in ASCE 7, Chapter 13 to the structure.

B. Seismic attachments, braces, and anchorages shall be designed in accordance with the provisions of the California Building Code and the site-specific criteria in Section 01611.

PART 2: PRODUCTS

1.07 MATERIALS

A. Attachments and supports transferring seismic loads to the structure shall be constructed of materials and products suitable for the application and designed and constructed in accordance with the design criteria shown on the Drawings and nationally recognized standards.

B. Powder driven fasteners and sleeve anchors shall not be used for seismic attachments and anchorage where resistance to tension loads is required.

C. Anchor Bolts: In accordance with Section 05501.

PART 3: EXECUTION

1.08 GENERAL

A. Design seismic anchorage systems to provide restraint in all directions, for each component or system so anchored.

B. Tall and narrow equipment such as motor control centers and electrical control panels shall be anchored at the base and within 12 inches from the top of the equipment.

C. Mechanical and electrical components shall not be attached to more than one element of a building structure at a single restraint location where such elements may respond

differently during a seismic event. Such attachments shall also not be made across building expansion and contraction joints.

D. Seismic attachments and braces shall be provided and installed by the Contractor in accordance with the size and number of braces determined by the design calculations prepared by the Contractor.

E. Anchor bolts and concrete and masonry anchors for the anchorage of equipment shall be provided and installed by the Contractor in accordance with the bolt sizing, minimum embedment, and spacing requirements determined by the calculations prepared by the Contractor.

END OF SECTION

SECTION 01611

SEISMIC DESIGN REQUIREMENTS

PART 1: GENERAL

1.01 SECTION INCLUDES

A. The following primary and secondary structural system elements, non-structural components, and/or equipment supported by structures.

1. Pre-Engineered Metal Buildings and Canopies.

2. Mechanical, electrical, and plumbing equipment and appurtenances.

3. Conduit, piping, cable trays, raceways, ducts and similar systems.

4. Tanks and vessels (include contents), including support systems.

5. Storage racks, suspended ceilings, light fixtures, raised floors, partitions, store-fronts, windows, louvers, architectural features and other non-structural components.

1.02 REFERENCED SECTIONS

A. The following Sections are referenced in this Section

1. Section 01300 – Submittals

2. Section 05500 – Metal Fabrications

1.03 REFERENCES

A. 2019 California Building Code (CBC)

1.04 DEFINITIONS

A. Engineer of Record: The Engineer responsible for the preparation of Contract Documents.

B. Specialty Engineer: Structural or Civil Engineer provided by the Contractor licensed in the State where the project is being built responsible for specific elements of the primary structural system, the secondary structural system, non-structural elements and/or equipment supported by structures.

1.05 GENERAL DESIGN REQUIREMENTS

A. The Contractor is responsible for producing designs that resist the total seismic forces in accordance with the seismic design criteria.

B. The Contractor is responsible for coordinating between the Engineer of Record and the Specialty Engineer.

C. The seismic design for non-structural components and equipment shall be in accordance with the CBC Chapter 16, and the required coefficients and factors for determining the total design seismic forces are provided in the Seismic Design Criteria in Paragraph D below.

D. Coordinate the layout so that adequate space is provided between items for relative motion. Provide additional supports and restraints between items of different systems when necessary to prevent seismic impacts or interaction.

E. Seismic forces shall be determined in accordance with the following seismic design criteria:

1. Site-Specific Spectral Response Coefficients

   a. Short Period Mapped Maximum Considered Earthquake, 5 Percent Damped: $S_s = 0.39$

   b. 1 Second Period Mapped Maximum Considered Earthquake, 5 Percent Damped: $S_1 = 0.189$

   c. Short Period Design Spectral Response Acceleration, 5 percent Damped: $S_{DS} = 0.338$

   d. 1 Second Period Design Spectral Response Acceleration, 5 percent Damped: $S_{D1} = 0.189$

2. Site Class: C

3. Seismic Design Category: C, unless noted otherwise

4. Risk Category: IV, unless noted otherwise

5. Component Importance Factor, Ip:

   a. Mechanical and Electrical Equipment: Use 1.5.

   b. Tanks and Tank Anchorage: Use 1.5.

   c. Components that contain hazardous materials: Use 1.5.

   d. Components that are required for life safety: Use 1.5.

e. Components that must remain functional after an earthquake, such as fire protection sprinkler systems: Use 1.5.

6. Do not use more than 60 percent of the weight of tanks and mechanical and electrical equipment for designing anchors for resisting overturning due to seismic forces.

7. Do not use friction to resist sliding due to seismic forces.

1.06 DESIGN REQUIREMENTS FOR PIPING, CONDUIT, AND DUCTS

A. The Contractor is responsible for producing designs for support of piping, conduit, duct or other systems to resist total seismic forces based on the seismic design criteria coefficients specified above, unless shown on the Contract Documents. Except where the technical specifications give specific exemption from resistance of seismic forces, all supports shall be designed to meet seismic criteria.

B. Where possible, pipes, conduit, and their connections shall be constructed of ductile materials (e.g., copper, ductile iron, steel or aluminum and brazed, welded or screwed connections). Pipes, conduits and their connections, constructed of nonductile materials (e.g., cast iron, no-hub pipe and plastic), shall have the brace spacing reduced to one-half of the spacing allowed for ductile material.

C. Seismic restraints may be omitted for the following conditions, where flexible connections are provided between components and the associated ductwork, piping and conduit:

1. Fuel piping less than 1-inch inside diameter.

2. All other piping less than 2.5-inches inside diameter or all piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the structural support for the hanger or electrical conduit less than 2.5-inches trade size.

3. All rectangular air-handling ducts less than 6 square feet in cross-sectional area or all round air-handling ducts less than 28-inches diameter or all ducts suspended by individual hangers 12 inches or less in length from the top of the duct to the bottom of the structural support for the hanger, where the hangers are detailed to avoid bending of the hangers and their connections.

D. All trapeze assemblies supporting pipes, ducts and conduit shall be braced to resist the total seismic forces considering the weight of the elements on the trapeze. Pipes, ducts and conduit supported by a trapeze where none of those elements would individually be braced need not be braced if connections to the pipe/conduit/ductwork or directional changes do not restrict the movement of the trapeze. If this flexibility is not provided, bracing will be required when the aggregate weight of the pipes and conduit exceed 10 pounds/foot. The weight shall be determined assuming all pipes and conduit are filled with water.

E. As an alternative to designing the supports and anchorage, where an approved national standard provides a basis for the earthquake-resistant design, submit standard, data, and details for piping, conduit, duct or other systems:

1. For ductwork, mechanical piping, process piping and electrical conduits, follow Guidelines for Seismic Restraints of Mechanical Systems by SMACNA modified as follows:

a. Seismically brace piping regardless of size or location. Provide transverse braces at all changes in direction and at the end of all pipe runs. Space transverse braces not more than 20 feet apart. Provide longitudinal braces at 40-foot centers.

b. Seismically brace all ductwork regardless of size or location. Provide transverse braces at all changes in direction and at each end of run. Space braces not over 20 feet apart. Provide longitudinal braces at 40-foot centers.

2. For fire protection systems, follow NFPA 13 modified as in Paragraph 1.b above. Ensure that no seismic interaction occurs with items of other systems.

1.07 DESIGN REQUIREMENTS FOR UNDERWATER ITEMS

A. To allow for water sloshing, design rigid items such as piping or equipment supports for twice the lateral force, computed as if the item were above water.

B. Design flexible items to accommodate sloshing motions without damage to rigid machinery.

C. Provide retainers to hold items from falling and damaging rotating equipment below, if bolted connections will fail because of ground motion displacing the supports.

1.08 SUBMITTALS

A. Comply with Section 01300.

B. Shop Drawings

1. Submit signed and sealed structural calculations and detailed drawings for the following listed elements and where required in Divisions 2 through 16 of the primary structural system and their attachments, the secondary structural system and their attachments, permanent non-structural components and their attachments, and the attachments and anchorage for all permanent equipment’s supported by the structures.

C. Structural calculations and detailed drawings shall be prepared by a Specialty Engineer licensed in the State where the project is being built.

D. Structural calculations and detailed drawings shall clearly show the total design seismic forces which will be transferred from the elements of the structural system, non-structural components, and/or equipment and their attachments to the primary structure.

E. The Engineer's review of items within a Specification Section cannot be completed until all related items have been coordinated and submitted for review.

F. Quality Assurance Submittals

1. Test Reports: Submit test reports for tension testing of anchors.

2. Where required in the equipment specifications in Divisions 2 through 16 submit certification that the equipment itself is designed to resist all internal seismic forces based on the seismic design criteria for the project.

3. Where required in the equipment specifications in Divisions 2 through 16, submit signed and sealed structural calculations and detailed drawings from a specialty Structural or Civil Engineer licensed in the State where the project is being built for the attachments and anchorage to the primary structure.

4. Where required in the equipment specifications in Divisions 2 through 16, submit certification that the attachments and anchorage are designed to resist all seismic forces based on the seismic design criteria for the project.

1.09 QUALITY ASSURANCE

A. Qualifications: The Contractor is responsible for submitting signed and sealed structural calculations and detailed drawings from a Specialty Structural or Civil Engineer licensed in the State where the project is being built.

B. Regulatory Requirements: Comply with the State of California adopted and amended versions of 2007 California Building Code (CBC) Chapter 16 - Earthquake Design plus clarifications and additions specified in this Section.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

1.10 FIELD QUALITY CONTROL

A. Site Tests: Tension testing of expansion or adhesive anchors utilized for anchorage shall be done in the presence of the special inspector and a report of the test results shall be submitted. See Specification Section 05501 for additional requirements.

B. Inspection: Special inspection shall be provided for high strength bolting or bolts installed in concrete. See Specification Section 05501 for additional requirements.

END OF SECTION

SECTION 01620

QUALITY CONTROL AND INSPECTION

PART 1: GENERAL

1.1 CONTRACTOR'S QUALITY CONTROL

A. General: The Contractor is to ensure that products, services, workmanship and Site conditions comply with the requirements of the Contract Documents by coordinating, supervising, testing and inspecting its Work. The Contractor shall utilize only suitably qualified, skilled and trained personnel experienced in the tasks required to complete the Work in accordance with the quality requirements of the Contract Documents. Should there be no quality basis specifically prescribed for any portion of the Work, the quality and testing procedures shall be in accordance with the best-accepted practices of the construction industry for the locale of the Project, for projects of this type, or standards set by engineering or technical societies (e.g. ASTM or ASHRAE), whichever is more stringent.

B. Quality of Work: The Contractor's quality of Work shall include, but not be limited to, the following requirements:

1. Quality of Products: Unless otherwise indicated or specified, all products shall be new, free of defects, and fit for the intended use.

2. Quality of installation: All Work shall be produced plumb, level, square and true, or true to indicated angle, and with proper alignment and relationship between the various elements, as shown on or required by Contract Documents.

3. Protection of Completed Work: Take all measures necessary to preserve completed Work free from damage, deterioration, soiling, and staining, until acceptance by Owner.

4. Standards and Code Compliance and Manufacturer's Instructions and Recommendations: Unless more stringent requirements are indicated or specified, comply with manufacturer's instructions and recommendations, reference standards and building code research report requirements in preparing, fabricating, erecting, installing, applying, connecting, and finishing Work.

5. Deviations from Standards and Code Compliance and Manufacturer's instructions and Recommendations: Secure Owner's advanced written consent. Document and explain all deviations from reference standards and building code research report requirements and manufacturer's product

installation instructions and recommendations, including acknowledgement by the manufacturer that such deviations are acceptable and appropriate for the Project.

6. Verification of Quality: Work shall be subject to verification of quality by Owner in accordance with provisions of the Contract Documents.

C. Defective Work:

Defective Work shall be modified, replaced, repaired or redone by the Contractor at no change in Contract Sum or Contract Time. Acceptance of Defective Work, without specific written acknowledgement and approval of Owner, shall not relieve the Contractor of the obligation to correct such Work. Should the Owner determine that it is not feasible or in the Owner's interest to require Defective Work to be repaired or replaced, an equitable reduction in Contract Sum shall be made by agreement between Owner and Contractor. If an equitable amount cannot be agreed upon, a Construction Change Directive will be issued and the amount in dispute resolved in accordance with the Contract Documents. Owner and Owner's consultants disclaim any and all responsibility for Work produced not in conformance with the Drawings and Specifications. Contractor shall have full responsibility for all consequences resulting from Defective Work, including without limitation all delays, disruptions, extra inspection and correction costs by Contractor and Owner and re-Work, and extra time and costs of all types. Contractor waives excuses for defective work relating to Owner's prior review of Submittals and/or prior failure to notice Defective Work in place on inspection.

PART 2: MATERIALS

Not used.

PART 3: EXECUTION

1.2 INSPECTION AND TESTING

A. General:

1. Where the Contract Documents require work to be field tested or approved, it shall be tested in the presence of the Construction Manager or its authorized representative. The Construction Manager shall have the right to witness all on-site tests performed by the Contractor and any shop tests. The results of any tests performed by the Contractor shall be made available for the information of the Construction Manager. Inspections, tests or favorable reviews by the Construction Manager or others shall not relieve the Contractor from its obligation to perform the work in accordance with the

requirements of the Contract Documents or for its sole responsibility for the quality of workmanship and materials.

2. Except as specifically required under the technical specifications for testing and inspection, all tests for materials furnished by the Contractor will be done in accordance with commonly recognized standards of national organizations. Where tests are to be performed by the Construction Manager or by an independent laboratory or agency, the Contractor shall furnish such samples of all materials as required by the Construction Manager without charge. The sample or samples of materials to be tested shall be selected by such laboratory or agency, or the Construction Manager, and not by the Contractor. No material for which the Contract Documents require the submittal and approval of tests, certificates of compliance or other documentation shall be incorporated in the Work until such submittal has been made and approved. The Contractor shall provide safe access, including plants where materials or equipment are manufactured or fabricated, for the Construction Manager and inspectors to adequately inspect the quality of work and the conformance with the Contract Documents. The Contractor shall furnish the Construction Manager the necessary labor and facilities for such things as excavation in the compacted fill to the depths required to take samples. The Contractor shall provide adequate lighting, ventilation, ladders and other protective facilities as may be necessary for the safe performance of inspections.

3. Upon completion of the Work the Construction Manager will conduct a final inspection as provided in Section 00700 – General Conditions. Records shall be available at all reasonable hours for inspection by other local or State agencies to ascertain compliance with laws and regulations.

4. Neither the employment of independent testing and inspection agency nor observations or tests by Owner and Owner's consultants shall in any manner relieve the Contractor of obligation to perform Work in full conformance to all requirements of the Contract Documents. The Owner reserves the right to reject all Work not in conformance to the requirements of the Contract Documents, or otherwise Defective.

B. Notice:

1. The Contractor shall notify the Construction Manager in writing at least one (1) business day before any field testing or special inspections are required to be performed by the Construction Manager or independent laboratory furnished by the Owner. The Contractor shall notify the Construction Manager at least two hours prior to the start of any inspections that are required to be performed or that are to be witnessed by the Construction Manager. Each day, the Contractor shall give due notice to the Construction Manager so that proper inspection may be provided. Any work done in the

absence of the Construction Manager shall be considered to be rejected. It will be the responsibility of the Contractor to demonstrate to the satisfaction of the Construction Manager that the work meets all conditions of the specification and if such conditions are not met to remove the work.

2. The Contractor shall give the Construction Manager written notification at least thirty (30) days prior to the shipment of materials and equipment to be tested and/or inspected at the point of origin. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the materials and equipment nor shall such tests and inspections preclude retesting or reinspection at the site of the Work.

C. Costs of Testing:

1. The Contractor shall be responsible for, and shall pay for, all quality control and off-site tests of materials required including all source and mix design tests for the approval of soil and concrete materials. The Owner will perform the soils and concrete confirmation tests detailed in the Technical Specifications during the performance of the Work. The Owner will retain and pay a qualified testing agency to perform soil compaction testing and work identified as requiring special inspections and testing as defined by CBC section 1701. All other testing required by the technical specifications shall be the responsibility of the Contractor.

2. The Contractor shall be responsible for, and shall pay for, all source quality control and all on-site tests of materials required, except those tests specifically noted to be performed and paid for by the Owner.

3. The Construction Manager shall have the authority to require additional tests or inspections due to the manner in which the Contractor executes its work. Examples of such additional tests and inspections include; tests of materials substituted for previously accepted materials, or substituted for specified materials, or retests made necessary by failure of material to comply with the requirements of the Specifications. Where such tests and inspections are required by Contract to be performed by the Owner, the Owner will pay for the additional tests and inspections but will issue a unilateral Change Order to deduct these costs from the Contract price.

D. Work Covered Prior to Inspection and/or Testing: Work requiring inspection and/or testing shall not be concealed or buried prior to the acceptance of such inspection or testing. Work covered without the favorable review or consent of the Construction Manager shall, if required by the Construction Manager, be uncovered for inspection and/or testing at the Contractor's expense.

E. Work Covered With Prior Inspection and/or Testing: If the Construction Manager considers it necessary or advisable that covered work which was favorably inspected and tested be uncovered for re-inspection and/or retesting, the Contractor, at the Construction Manager's request, will uncover, expose or otherwise make available for observation, inspection or testing as the Construction Manager may require, that portion of the work in question, furnishing all necessary labor, materials, tools, and equipment. If it is found that such work is defective, the Contractor will bear all expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction. If, however, such work is not found to be defective the Contractor will be allowed an increase in the Contract price or an extension of the Contract time, or both, directly attributable to such uncovering, exposure, observation, testing and reconstruction, and a Change Order shall be issued for such additional work.

F. Coordination of County, District Building and Other Inspections: The Contractor is completely responsible for scheduling all County, District and any other agency inspections in accordance with the County, District and agency requirements. The Contractor shall notify the Construction Manager of all building and other work component inspection notices and schedules. Failure of the Contractor to properly coordinate and schedule these inspections shall not be cause for time extensions.

G. Special Tests and Inspections: As provided for in the Contract Documents, laws and regulations, specialized tests and inspections shall be performed by special inspectors certified by the International Code Council (ICC). Unless otherwise stated in the Contract Documents, each of these tests will be performed and paid for by the Owner.

H. Inspections and Tests by Serving Utilities: Unless otherwise indicated in the Contract Documents, the Contractor shall cause, schedule and conduct inspections and tests by serving Utilities required for the Work under this Contract.

I. Inspections and Tests by Serving Manufacturers: Unless otherwise indicated in the Contract Documents, the Contractor shall cause all required tests and inspections to be conducted by materials, equipment or systems manufacturers. Additionally, all tests and inspections required by materials, equipment or systems manufacturers as conditions of warranty or certification of Work shall be made, the cost of which shall be included in the Contractor’s bid.

1.3 TEST WATER

A. The Owner will furnish non-potable well water for testing to the Contractor, if available from the Owner’s plant water system. The conveyance of water shall be the responsibility of the Contractor and shall be at the Contractor’s expense.

B. The Contractor shall submit a written request of water needs for testing including a description, volume, location and duration of use to the Construction Manager for approval. The Construction Manager will designate the type of water, locations where connections may be made and the backflow protection, if required. The Contractor is responsible for providing, installing and testing the backflow prevention device at the Contractor's expense. The Construction Manager may also require a meter on the connection depending on the volume of water requested.

C. There may be short periods of time when water is not available from the Owner's system.

END OF SECTION

SECTION 01640

PRODUCT REQUIREMENTS AND HANDLING

PART 1: GENERAL

1.01 SUMMARY

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

1.02 DESCRIPTION

A. Work Included: Protect products scheduled for use in the work by means including, but not necessarily limited to, those described in this Section.

B. Related Work: Documents affecting the work of this Section include, but are not necessarily limited to, General Conditions, Special Provisions, and Sections in Division 1 of these Specifications.

Additional procedures also may be prescribed in other sections of these Specifications, including specific handling instructions recommended in the Manufacturer's literature.

1.03 DEFINITIONS

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

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

1.04 PRODUCT REQUIREMENTS

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

B. Materials and equipment to be incorporated into the project shall be new. In case a reference is not clear, a "Request for Information" (RFI) is to be transmitted to the Construction Manager.

C. Provide products by the same manufacturer when products are of a similar nature, unless otherwise specified.

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

E. Provide products with interchangeable parts whenever possible.

F. Require each equipment manufacturer to have maintenance facilities meeting the following requirements:

1. Minimum 3 years operational experience.

2. Location in continental United States.

3. Equipment and tools capable of making repairs.

4. Staff qualified to make repairs.

5. Inventory of maintenance spare parts.

1.05 PRODUCT SELECTION

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

B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide:

1. Products by one of the named manufacturers that meet or exceed Specifications.

2. Accepted or equal.

C. When products are specified with names of manufacturers and model numbers or catalog designations, provide:

1. Products with model numbers or catalog designations by one of named manufacturers.

2. Accepted or equal.

D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:

1. Products specified by brand or trade name, model number, or catalog designation.

2. Products by one of named manufacturers proven in accordance with requirements for or equals to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.

3. Accepted or equal.

E. When Products are specified with only one manufacturer followed by "or Equal," provide:

1. Products meeting or exceeding Specifications by specified manufacturer.

2. Accepted or equal.

1.06 PRODUCT OPTIONS AND SUBSTITUTIONS

A. General: Whenever a product is specified using the name of a particular manufacturer or supplier, the specific item cited shall be understood as establishing type, function, dimension, appearance, and quality desired. Other manufacturer's products will be considered for acceptance provided sufficient information is submitted to the ENGINEER for review to determine that the products proposed are equivalent to those named.

1.07 QUALITY ASSURANCE

A. Include within the Contractor's quality assurance program such procedures as are required to assure full protection of work and materials.

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

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

D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.08 DELIVERY, HANDLING, STORAGE, AND PROTECTION

A. Prepare products for shipment by:

1. Applying grease and lubricating oil to bearings and similar items.

2. Separately packing or otherwise suitably protecting bearings.

3. Tagging or marking products to agree with delivery schedule or shop drawings.

4. Including complete packing lists and bills of material with each shipment.

5. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.

B. Transport products by methods that avoid product damage. Deliver products in

undamaged condition in manufacturer's unopened containers or packaging.

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

D. Upon delivery, promptly inspect shipments.

1. Verify compliance with Contract Documents, correct quantities, and undamaged condition of products.

2. Immediately store and protect products and materials until installed in Work.

E. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment and special equipment to be incorporated into this project.

1. Storage of equipment shall be in strict accordance with the “instructions for storage” of each equipment supplier and manufacturer including connection of heaters, placing of storage lubricants in equipment, etc.

2. The Contractor shall furnish a copy of the manufacturer’s instructions for storage to the Engineer prior to storage of all equipment and materials.

3. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project.

4. Equipment and materials not properly stored will not be included in a application for payment.

F. Store products with seals and legible labels intact.

G. Store moisture sensitive products in weather tight enclosures.

H. Maintain products within temperature and humidity ranges required or recommended by manufacturer.

I. Maintain storage areas at ambient temperatures recommended by manufacturer.

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

K. Exterior storage of fabricated products:

1. Place on aboveground supports that allow for drainage.

2. Cover products subject to deterioration with impervious sheet covering.

3. Provide ventilation to prevent condensation under covering.

L. Store loose granular materials on solid surfaces in well-drained areas. Prevent materials contaminated with foreign matter.

M. Provide access for inspection.

N. Maintain equipment per the manufacturer's recommendation and industry standards, including oil changes, rotation, etc. Provide a log of equipment maintenance to the Engineer on a monthly basis.

1. Rotation log shall include, as a minimum, the equipment identification, date stored, date removed from storage, copy of manufacturer's recommended storage guidelines, date of rotation of equipment, and signature of party performing rotation.

O. Protection after installation:

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

1.09 MANUFACTURERS' RECOMMENDATIONS

A. Except as otherwise approved by the Engineer, determine and comply with manufacturers' recommendations on product handling, storage, and protection. Rotating equipment storage shall include recommended manual rotation frequency with a log prepared by the Contractor to demonstrate specification compliance. The Contractor shall contact the Resident Engineer prior to performing the scheduled rotation. An Inspector may accompany the Contractor's workmen during the required rotation.

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

C. Periodically inspect to ensure products are undamaged and maintained under required conditions.

1.010 PACKAGING

A. Deliver products to the job site in manufacturer's packaging material with seals unbroken and labels intact until time of use. Promptly remove damaged material and unsuitable items from the job site, and promptly replace it with material meeting the specified requirements, at no additional cost to the Owner.

B. The Engineer may reject as non-complying- such material and products that do not bear identification satisfactory to the Engineer as to manufacturer, grade, quality, and

other pertinent information.

C. Copies of all equipment delivery tags shall be provided to the engineer on a daily basis with delivery tag indicating equipment number, item description, model number, and serial number.

1.011 PROTECTION

A. Protect finished surfaces, including jambs and soffits of openings used as passageways, through which equipment and materials are handled.

B. Provide protection for finished floor surfaces in traffic areas prior to allowing equipment or materials to be moved over such surfaces.

C. Maintain finished surfaces clean, unmarred, and suitably protected until accepted by the Owner.

D. Protect materials and equipment from the effects of weather, sunlight, extreme temperatures, etc., when exposure of the materials or equipment to the elements would cause degradation of, or damage to, the material, equipment or coating system. Payments for materials and equipment stored on-site will only be made when the materials or equipment are suitably stored.

E. Exercise installed equipment and provide maintenance per manufacturer's recommendations until the project is accepted by the Owner.

1.012 REPAIRS AND REPLACEMENTS

A. In the event of damage, promptly make replacements and repairs to the approval of the Engineer and at no additional cost to the Owner.

B. Additional time required to secure replacements and to make repairs will not be considered by the Engineer to justify an extension in the Contract Time of Completion.

1.013 SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

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

B. Box, tag, and clearly mark items.

C. Store spare parts, maintenance products, and special tools in enclosed, weather- proof, and lighted facility during the construction period.

1. Contractor is responsible for spare parts and special tools until acceptance by Owner.

2. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.

PART 2: MATERIALS

Not Used.

PART 3: EXECUTION

Not Used.

END OF SECTION

SECTION 01666

TESTING OF GRAVITY SEWER LINES AND MANHOLES

PART 1: GENERAL

1.01 DESCRIPTION

A. The work of this section consists of testing gravity sewer lines and gravity sewer manholes. All repaired work shall be retested.

B. Testing Methods:

1. Gravity sewer lines – Mandrel Test

2. Gravity sewer lines – Air Test

3. Manholes – Vacuum test to be used for manholes. Vacuum test to conform to ASTM C1244.

1.02 QUALITY ASSURANCE

A. Flow meters shall record the actual volume plus or minus 2 percent.

B. Air test gauges shall be ANSI/ANSI B40.1, Grade 3A (plus or minus 0.25 percent of full-scale accuracy), 15 psi dial range.

C. Water test gauges shall be ANSI/ANSI B40.1, Grade 2A (plus or minus 0.5 percent of full-scale accuracy), dial range approximately twice the required test pressure.

1.03 SUBMITTALS: In accordance with Section 01300.

A. Accuracy certification by approved independent testing labs for flow meters and test gauges. Certifications shall be dated no more than 90 days prior to actual system testing.

B. The Contractor shall notify the construction manager a minimum of seven (7) business days in advance of its proposed testing schedule for review and concurrence.

C. Prior to testing, provide the following information:

1. All Tests: Describe precautions that will be taken to protect system equipment that might be damaged under test pressures, and the proposed method for rerouting sewer flows where the system must remain in service.

2. Air Test: Describe safety devices on air test equipment and personnel safety precautions during air test.

1.04 PROJECT CONDITIONS

Testing shall not be performed until each system has been flushed or thoroughly cleaned in accordance with procedures in the section that describes sewer line installation.

PART 2: MATERIALS

Not Used.

PART 3: EXECUTION

3.01 GENERAL

Prepare each section for testing, using adequate bracing; protect system equipment susceptible to damage by test pressures; make provision for installation of Agency's pressure gauge in parallel with Contractor's gauge, if so requested; and maintain services where required.

3.02 GRAVITY SEWER SYSTEMS

A. Mandrel Test (Deflection) for Gravity Sewers

1. After completion of the sewer line, the line shall be hydro cleaned just prior to pulling the mandrel through. Debris from flushing shall be screened (¼-inch mesh screen) and collected so as not to enter into the existing system.

2. All sewer lines shall be tested for obstructions with an approved seven- and one-half percent (7½%) mandrel and hydro cleaned.

3. Any obstructions or irregularities shall be removed or repaired by the Contractor. All testing, cleaning, and repairing shall be done to the satisfaction of the Engineer. The Contractor shall dispose of all waste, including water, at its own expense. The water shall not be allowed to enter existing sanitary sewer systems without prior approval of the Engineer.

B. Air Test: Test lines less than or equal to 30 inches in diameter between manholes with low pressure air. Safety requires regulator or relief valve on pressurizing equipment, set at 8 psig. No one will be allowed in manholes while there is air pressure against test plugs.

1. Lines greater than 30-inches in diameter shall include individual joint testing as specified.

2. Plug all pipe outlets to resist test pressure. Give special attention to laterals. Plug all other pipes in both upstream and downstream manholes.

3. Supply air into the line until the test pressure of 3.5 psi in excess of the

ground water pressure is attained or 8 psi, whichever is greater. Allow at least 5 minutes for air temperature in the test section to stabilize.

4. Re-establish the test pressure and start a stopwatch. Determine the time required for pressure to drop 1.0 psig.

5. For 6-inch and smaller pipe only, if the pressure does not drop during the stabilization period, and no additional air has been added, the section undergoing test will have passed without further testing.

6. The pipe section will also have passed if the time observed for the pressure to drop 1.0 psig is greater than that determined by using Table 1.

   Determine the test time from Table 1 (minimum time 60 seconds).

Table 1 – Minimum Test Time for Various Pipe Sizes

SIZE	Time per 100-feet	SIZE	Time per 100-feet	SIZE	Time per 100-feet
4-inch	0.3-min.	12-inch	1.8-min.	24-inch	3.6-min
6-inch	0.7-min.	15-inch	2.1-min.	27-inch	4.2-min.
8-inch	1.2-min.	18-inch	2.4-min.	30-inch	4.8-min.
10-inch	1.5-min.	21-inch	3.0-min.		

7. When a combination of more than one pipe size is under test, the calculated time for the larger pipe shall apply.

8. For larger sewer pipes, refer to the material specification for testing requirements.

3.03 MANHOLE TEST

A. All manholes shall be vacuum tested for leakage after assembly but prior to backfilling, mortaring of joints, application of coatings, and welding of liner seams. The Contractor shall furnish all labor, tools, and equipment necessary to make the tests and to perform any work incidental thereto. The Contractor shall correct any excess leakage and repair any damage to the manhole and its appurtenances at its own expense. The vacuum test shall be as follows:

1. All lift holes and inside and outside joints shall be plugged with an approved non-shrink grout.

2. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole.

3. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendations.

4. A vacuum of ten (10) inches of mercury (approximately five (5) psi) shall be drawn and the vacuum pump shut off.

5. With the valves closed, the time shall be measured for the vacuum to drop to nine (9) inches. The manhole shall pass if the time is greater than:

   a. 60 seconds for 48" diameter manholes

   b. 75 seconds for 60" diameter manholes

   c. 90 seconds for 72" diameter manholes.

If the manhole fails the initial test, necessary repairs shall be made with a non shrink grout while the vacuum is still being drawn. Re-testing shall proceed until a satisfactory test is obtained. The manhole shall be visually inspected after backfill operations. Should shifting or other movement occur, the manhole is to be re-tested.

3.04 VISUAL TEST FOR PIPELINES

Interior visual inspection shall be conducted by the Owner and/or CCTV inspection may be performed by the Owner. The Owner's Inspector shall visibly inspect the line and record findings. Preliminary inspections may be performed by outside contractors but shall not be accepted by Engineer as an official record.

The sewer system shall be completely cleaned by an approved method prior to visual inspection. The sewer system shall be rejected if any of these conditions exist:

A. Standing water or sags greater than ½-inch in depth.

B. Standing water in services.

C. Offset joints.

D. Cracked pipe.

E. Infiltration.

END OF SECTION

SECTION 01667

TESTING OF PIPELINES

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of leak testing all pipelines and related valves and fittings. Rejected work shall be retested, and if still rejected shall be repaired or replaced to the satisfaction of the Engineer at no additional cost to the Owner.

1.02 QUALITY ASSURANCE

A. Flow meters shall record the actual volume plus or minus 2 percent.

B. Air and vacuum test gauges shall be ANSI B40.1, Grade 3A (plus or minus 0.25 percent of full-scale accuracy), with a dial range approximately twice the required test pressure.

C. Water test gauges shall be ANSI B40.1, Grade 2A (plus or minus 0.5 percent of full-scale accuracy), with a dial range approximately twice the required test pressure.

1.03 SUBMITTALS: In accordance with Section 01300.

A. Accuracy certification by approved independent testing laboratories for flow meters and test gauges. Certifications shall be dated no more than 90 days prior to actual system testing.

B. Prior to testing, provide the following information:

1. All Tests: Describe precautions that will be taken to protect system equipment that might be damaged under test pressures, and the proposed method for rerouting reclaimed water or sewer flows where the systems must remain in service.

2. Air Test: Describe safety devices on air test equipment, and personnel safety precautions during air tests.

3. High or Low Pressure Water Test: Describe the proposed method for disposal of water used in line testing, coordinate with requirements of specification section 01656.

1.04 PROJECT CONDITIONS

A. Testing shall not be performed until each system has been flushed or thoroughly cleaned in accordance with procedures in the section that describes pipeline installation.

B. Water for flushing and testing is available as described in Section 01010.

PART 2: MATERIALS

Not Used.

PART 3: EXECUTION

3.01 GENERAL

A. Perform testing in the Engineer's presence after backfill and proper compaction of trenches. Where lines are installed under roadways and parking areas, perform tests after completion of final subgrade preparation and prior to application of surface courses. Notify Engineer in writing at least two working days prior to testing. Notification shall be by the Contractor submitting a test form which shall indicate test date, pipeline to be tested, test requirements and requirements of the Owner.

B. Prepare each section for testing, using adequate bracing; protect system equipment susceptible to damage by test pressures; make provision for installation of Owner's pressure gauge in parallel with Contractor's gauge, if so requested; and maintain services where required.

3.02 TEST PROCEDURE

A. After completion of the installations, Contractor shall test all piping and pipework as herein specified. The Contractor shall furnish all material, equipment, and labor for testing the piping systems.

B. Each system may be tested as a unit or in sections as directed by the Engineer, but each complete system shall successfully meet the requirements specified herein before acceptance by the Engineer.

C. For water testing, the test shall be made by closing valves or providing bulkheads or plugs and filling the pipelines with water, with provisions made for the release of all air in the lines. Lines shall be filled with water 24 hours prior to testing for leakage to allow for absorption of water by pipe or joint material.

D. Specified pressures or heads of water shall be maintained for the periods of time tabulated herein, except where indicated to be air or vacuum, and the leakage determined. Leakage shall not exceed the tabulated values.

E. Test pressures shall be as indicated herein and in Section 15010.

F. If leakage is more than allowable, the Contractor shall repair or replace the pipeline and retest it. Do not use paints, asphalts, tars, or other types of pipe compounds to eliminate leaks.

G. The Contractor shall take all necessary precautions to prevent any joints from drawing while the pipelines and their appurtenances are being tested and he shall, at his own expense, repair any damage to the pipes and their appurtenances, or to any other structures, resulting from or caused by these tests.

TESTING REQUIREMENTS

Type of Pipe	Test Medium	Minimum Test Period	Maximum Allowable Leakage
Natural Gas	(a)	(a)	(a)
Propane	(a)	(a)	(a)
Digester Gas	Air	3 hours	0
Sanitary Drain	(a)	(a)	0
Storm Drain/Culverts	-	-	No Test
Service Air	Air	1 hour	0
Low Pressure Air Piping	Air	1 hour	0
Liquid-Containing Lines Not Listed Above	Water	3 hours	(b)

(a) Per applicable plumbing code

(b) Exposed pipe shall have no visible leaks.
Otherwise, allowable leakage shall be determined by the following formula:

$$L = \frac{SD\,(P)^{1/2}}{133{,}200}$$

Where:

L = allowable leakage, in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of the pipe, in inches

P = average test pressure during the leakage test, in pounds per square inch (gauge)

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1: GENERAL

1.01 CLOSEOUT TIMETABLE

The Contractor shall establish dates for equipment testing, interim final inspections, and on-site instructional periods (as required under the Contract). These dates shall take into account the interim completion dates noted in the Agreement. Such dates shall be established not less than five working days prior to beginning any of the foregoing items, to allow the Owner, the Engineer, and their authorized representatives sufficient time to schedule attendance at such activities. The testing requirements of Section 01010, Paragraph 3.08; Tests and Inspection, shall be adhered to.

1.02 FINAL CLEANUP

The Contractor shall promptly remove from the vicinity of the completed work all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the work by the Owner will be withheld until the Contractor has satisfactorily complied with the foregoing requirements for final cleanup of the project site.

1.03 MAINTENANCE AND GUARANTEE

A. The Contractor shall comply with the maintenance and guarantee requirements contained in the General Conditions and Supplementary Conditions.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered required repair work, and any repair or resurfacing constructed by the Contractor which becomes necessary by reason of such settlement shall likewise be considered required repair work.

C. The Contractor shall make all repairs and replacements promptly upon receipt of written order from the Owner. If the Contractor fails to make such repairs or replacements promptly, the Owner reserves the right to do the work and the Contractor, and his surety shall be liable to the Owner for the cost thereof.

1.04 BOND

The Contractor shall provide a two (2) year maintenance and guarantee bond to guarantee performance of the provisions contained in Paragraph “Maintenance and Guarantee” above.

PART 2: MATERIALS

2.01 CLEANING MATERIALS

As recommended by the manufacturer of surface to be cleaned.

PART 3: EXECUTION

3.01 CLEANING

A. Exterior Cleaning: Sweep paved surfaces; rake other surfaces or grounds.

B. Final Cleaning: Remove all tools, equipment, surplus materials, and rubbish. Refinish surfaces of existing facilities that are marred, scratched, or damaged to match original condition. Remove grease, dirt, stains, foreign materials, and labels from interior and exterior finished surfaces. Do any required waxing and polishing. At the time of final inspection, the project shall be thoroughly clean and ready for use.

3.02 PROJECT RECORD DRAWINGS

A. Using red colored ink, make changes on a set of clean prints of original tracings. Show all changes and revisions to the original design that affect the permanent structures and will exist in the completed work. Reference underground utilities to semi-permanent or permanent physical objects. Reference water, sewer, telephone, and electric lines to corners of buildings. Show invert elevations at structures, grade changes, valves, and fittings for all pipelines 6-inches in diameter and larger. Include schematic diagrams for all electrical equipment with terminal numbers shown.

B. Keep record drawings current. Inspection will be made monthly and will be required prior to the submittal of Progress Payments. Certification by the Contractor of accuracy and completeness will be required on monthly submitted payment requisitions. Project record drawings are the property of the Owner and shall be delivered to the Engineer before closeout.

3.03 SUBSTANTIAL COMPLETION AND FINAL INSPECTION

A. Submit written certification that the project, or a designated portion of the project, is substantially complete, and request, in writing, a final inspection. The Engineer will make an inspection within 10 days of receipt of the request.

B. When the Engineer determines that the work is substantially complete, he will prepare a list of deficiencies that need to be corrected before final acceptance and issue a certificate of Substantial Completion with the deficiencies noted.

C. If the Engineer determines that the work is not substantially complete, he will immediately notify the Contractor, in writing, stating reasons. After completing work, the Contractor shall resubmit certification and request a new final inspection.

3.04 ACCEPTANCE OF THE WORK

A. After all deficiencies have been corrected, a Letter of Final Acceptance will be issued.

B. Acceptance may be given before correction of deficiencies that do not prevent operation and use of the facility; however, final payment will be withheld until all deficiencies are corrected.

C. Until receipt of the Letter of Final Acceptance, the Contractor shall be responsible for the work of this Contract.

3.05 OPERATING INSTRUCTIONS

After equipment and systems are complete and operating, the Contractor or his suppliers shall, in cooperation with Engineer, instruct Owner personnel how to operate them.

3.06 START-UP/TRAINING

The Contractor shall demonstrate systems and instruct Owner personnel in their correct operation. This instruction shall include familiarizing the Owner's personnel with locations of switches, junction boxes, and circuiting. The Contractor shall have completed all startup and training defined in each individual applicable specification before project closeout.

3.07 CLOSEOUT SUBMITTALS

A. Submit before payment request.

B. Project Record Drawings: As specified above.

C. Written Guarantees and Bonds: As specified in individual sections.

D. Spare Parts, Special Tools, and Materials: As specified in individual sections.

E. Keys and Keying Schedule: Submit all keys including duplicates. Wire all keys for each lock securely together. Tag and plainly mark with lock number or equipment identification, and indicate physical location, such as building and room name or number, or panel or switch number.

F. Operating Handles and Special Tools: Clearly identify as to related equipment.

3.08 POST-CONSTRUCTION INSPECTION

Before expiration of guaranty period, Engineer will inspect project and notify Contractor in writing of all deficiencies.

END OF SECTION

Section 02010

SUBSURFACE CONDITIONS

PART 1: GENERAL

1.01 DESCRIPTION

A soil investigation report entitled "Geotechnical Engineering Investigation Report Proposed City of Colusa Wastewater Treatment Plant Infrastructure Improvements", dated September, 2023, has been prepared by NV5. Approximate soil boring locations and boring logs included in the report are for Contractors information, but the report is not a warrant of subsurface conditions. A copy of this report is included in Appendix B of the Contract Documents.

1.02 ADDITIONAL INFORMATION

Prior to bidding, the Contractor should visit the site and acquaint himself with all existing conditions. Bidders may make their own subsurface investigations to satisfy themselves as to site and subsurface conditions including, but not limited to, soil moisture conditions, current groundwater elevations, depth to bedrock and soundness of bedrock. Such subsurface investigations shall be performed only under time schedules and arrangements approved in advance by the Owner. Neither the Owner nor its Consulting Design Engineers guarantee the accuracy of the information contained in the Geotechnical Report or any interpretation, deduction, or conclusion given in the report relative to subsurface conditions. Further it shall be the responsibility of the Contractor to satisfy himself of the type of soil and the level of the water table to be encountered during construction of the facilities. The bidder shall make his own deductions and conclusions as to the nature of the materials to be excavated; the difficulties which may arise from the subsurface conditions and of doing any other work affected by the subsurface conditions and shall accept full responsibility therefore.

1.03 QUALITY ASSURANCE

A Geotechnical Engineer will be retained by the Owner to provide testing and inspection of work in connection with excavating, filling, compacting, and grading.

PART 2: MATERIALS

Not Used.

PART 3: EXECUTION

Not Used.

END OF SECTION

SECTION 02100

DEMOLITION, CLEARING, GRUBBING, AND STRIPPING

PART 1: GENERAL

1.01 DESCRIPTION

Work Included: Demolition, clearing, grubbing, and stripping required for this work includes, but is not necessarily limited to:

A. Felling and removal of trees, stumps, roots, and tree debris.

B. Removal of surface rock and all debris.

C. Removal of surface organic topsoil layer.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02010: Subsurface Conditions

B. Section 02210: Site Grading

C. Section 02221: Trenching, Backfilling, and Compacting

D. Section 02225: Structure Excavation and Backfill

E. Section 02270: Stormwater Runoff Control Program

F. Section 15010: General Process and Onsite Utility Piping Provisions

G. Appendix B: Geotechnical Report

1.03 LIMITS OF WORK

Perform demolition, clearing, grubbing, and stripping operations to the following limits:

A. Clearing: Perform clearing operations as needed to execute the construction work.

B. Grubbing: Perform grubbing operations at all locations identified for clearing.

C. Stripping: Perform stripping operations as needed to execute the construction work.

1.04 CLEARING

A. Unless otherwise specified in the Geotechnical Report perform clearing operations as directed below:

1. Remove and dispose of trees, snags, stumps, shrubs, brush, limbs, and other vegetative growth to the limits defined in Section 1.03. Remove all evidence of branches greater than 1-inch in diameter of thickness. Remove and dispose of trash piles and rubbish. Protect structures and piping above and below ground, trees, shrubs, and vegetative growth and fencing which are not designated for removal or which exist outside project limits.

1.05 GRUBBING

A. Unless otherwise specified in the Geotechnical Report perform grubbing operations as described below:

1. After clearing, remove and dispose of wood or root matter, including stumps, trunks, roots, or root systems greater than 1-inch in diameter to the limits defined in Section 1.03.

1.06 STRIPPING

A. Unless otherwise specified in the Geotechnical Report perform stripping operations as described below:

1. After grubbing, strip the organic material to the limits defined in Section 1.03 to a depth of not less than 6-inches. Upon completion of the stripping operation, the remaining material, if utilized for structural fill, shall not exceed a concentration of organics in excess of 3 percent by dry weight. Dilution shall be accomplished by means of disking.

1.07 QUALITY ASSURANCE

A. Qualifications of Workmen: Provide at least one person who shall be present at all times during tree clearing and grubbing operations and who shall be thoroughly familiar with the types of trees involved and who shall direct the trimming of roots and limbs where required. All tree removal and trimming shall be in compliance with applicable Colusa County Standards and ordinances.

B. Codes and Standards: In addition to complying with all pertinent codes and regulations comply with the requirements of those insurance carriers providing coverage for this work.

1.08 JOB CONDITIONS

A. Dust Control: Use all means necessary to prevent the spread of dust during performance of the work; thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the site. Wind in excess of 10 MPH causing dust to leave site will require Contractor to limit dust causing activities.

B. Burning: On-site burning will not be permitted.

C. Protection: Use all means necessary to protect existing objects designated to remain and, in the event of damage, immediately notify the Engineer and make all repairs and replacements necessary for approval by the Engineer at no additional cost to the Owner.

PART 2: MATERIALS

2.01 TEMPORARY BARRICADES

Unless otherwise specifically approved by the Engineer, use only new and solid lumber of utility grade or better to construct temporary barricades around the objects designated to remain.

2.02 EXPLOSIVES

Use of explosives on this job will not be allowed unless specifically approved by the Owner and Engineer.

2.03 OTHER MATERIALS

All other material, not specifically described but required for proper completion of the work of this Section, shall be as selected by the Contractor subject to approval of the Engineer.

PART 3: EXECUTION

3.01 PREPARATION

A. Notification: Notify the Engineer at least two full working days prior to commencing the work of this section.

B. Site Inspection:

1. Prior to all work of this section, carefully inspect the entire site and all objects designated to be removed and to be preserved.

2. Locate all existing inactive utility lines to be encountered by the new work and determine all requirements for disconnecting and capping. Abandonment of piping requires capping at each end or plugging with concrete to the satisfaction of the Engineer.

3. Locate all existing active utility lines traversing the site and determine the requirements for their protection.

C. Clarification:

1. The Drawings do not purport to show all objects existing on the site.

2. Before commencing the work of this section, verify with the Engineer all objects to be removed and all objects to be preserved.

D. Scheduling:

1. Schedule all work in a careful manner with all necessary consideration for neighbors, operation of existing facilities, and the public.

2. Avoid interference with the use of, and passage to and from, adjacent buildings and facilities.

E. Disconnection of Utilities: Before starting site operations, disconnect or arrange for the disconnection of all utility services designated to be removed, performing all such work in accordance with the requirements of the utility company or Owner involved.

F. Protection of Utilities: Preserve in operating condition all active utilities traversing the site and designated to remain.

3.02 STRUCTURE DEMOLITION (NOT USED)

A. Facilities so designated on the plans shall be demolished, and all materials therefrom shall become the property of the Contractor and shall be removed and disposed of away from the site. Any equipment or pipework connected within a structure which is designated to be removed and saved or relocated shall be removed and delivered to the storage facility as directed by the Engineer before demolition begins. All other equipment within the structure shall become the property of the Contractor.

B. All concrete and rock shall be removed to firm undisturbed soil and scarified to a depth of 12 inches, unless otherwise noted, and shall be disposed of off-site. Concrete not removed shall be broken to prevent entrapment of water, as directed by the Engineer. Concrete includes all reinforcement and embedded items. Pipework and conduit within 10 feet of a structure shall also be removed to firm undisturbed soil and scarified to a depth of 12 inches unless otherwise noted.

C. Safety Requirements: The Contractor's attention is directed to the provisions of Subpart T of the OSHA Safety and Health Standards for Construction and the provisions of Article 31 of the Construction Safety Orders of the California Division of Industrial Safety governing the work of demolition. The Contractor shall perform all the work hereunder in accordance with said provisions, and where in conflict, the more stringent shall apply.

D. Backfill and Grading: After facilities have been demolished and all material removed, any remaining depression or hole shall be backfilled and the area finish

graded as specified in specification Section 02210 Site Grading. Rubble and broken concrete will not be allowed to be used as fill material.

3.03 ROADWAY DEMOLITION (NOT USED)

A. Where shown on the contract drawings, the Contractor shall remove entire pavement section including base material. This will also be necessary where deemed by the Engineer that extensive pipe construction has caused a loss of pavement integrity. Base material may be stockpiled and reused where appropriate and only with the approval of the Engineer.

B. Asphalt concrete, concrete curb, and gutter materials to be demolished shall be removed from the site by the Contractor at no additional cost to the Owner.

3.04 PIPE DEMOLITION (NOT USED)

A. Unless otherwise specified, or in conflict with a proposed pipeline or structure, all pipes shown to be demolished shall be abandoned in place and have each end capped with at least a 24-inch long plug of class C concrete or grout material within the pipe. Piping subject to internal pressure upon abandonment shall be capped with pressure retaining caps or plugs.

B. All pipe materials to be removed including pipe, fittings, valves, and thrust blocking shall be removed from the site by the Contractor at no additional cost to the Owner.

3.05 CLEARING AND GRUBBING

A. Area to be Cleared & Grubbed:

1. The Contractor shall restrict clearing and grubbing to the areas designated for new construction or adjustment of grades on the plans. Surrounding trees shall be protected from damage.

2. Where limbs or roots of trees designated to remain extend into work areas, the limbs or roots shall be trimmed in accordance with the provisions of this section.

B. Felling of Trees:

1. Use all necessary care to protect the roots and branches of trees designated to remain, and to prevent damage to persons and properties.

2. Immediately after felling a tree, remove the branches, cut trunk and limbs as necessary for removal, and clear the debris. Remove tree roots within a minimum of 3 feet below the proposed finish grade.

C. Trimming of Trees:

1. In company with the Engineer, ascertain the limbs and roots which are to be trimmed and clearly mark them to designate the approved point of cutting.

2. Cut evenly, using proper tools and skilled workmen to achieve neat severance with the least possible damage to the tree.

3. In the case of root cuts, apply wet burlap or other protection approved by the Engineer, as required, to prevent drying out.

D. Grubbing:

Remove all surface rocks and all stumps, roots, and vegetation within the limits of construction. Roots shall be removed to at least 3 feet below proposed finish grade.

3.06 PLACEMENT OF STRIPPINGS

As directed by the Engineer, initially stockpile strippings and then spread on project site area indicated on the Drawings.

3.07 CONSTRUCTION OF BARRICADES

A. Layout:

1. At all trees designated to be preserved, construct a temporary barricade around the tree at the tree's approximate drip line.

2. Construct barricades at least three feet high, consisting of two inch by four inch or larger posts set at least 18 inches into the ground at not more than six feet on centers, joined at the top by one inch by six inch or larger boards firmly nailed to the posts. Metal post with orange safety fencing may also be used if allowed by the local Owner having jurisdiction.

B. Protection:

1. Take special care in setting posts to not damage tree roots.

2. Do not permit stockpiling of materials or debris within the barricaded area nor permit the earth surface to be changed in any way except as specifically approved by the Engineer.

C. Maintenance: All protective fencing shall be inspected and maintained by the contractor at weekly intervals. Any damaged fencing shall be restored within one week.

D. Removal of Barricades: All protective fencing including posts and fabric shall be removed from the site at the completion of the work at the Contractor's expense.

3.08 REMOVAL OF DEBRIS

A. Remove all debris from the site and leave the site in a neat and orderly condition to the approval of the Engineer. Dispose of debris off site at a location approved by the Engineer.

B. Removal of demolished materials shall be included in the applicable lump sum base bid item and shall not be paid on a unit cost basis.

END OF SECTION

SECTION 02140

DEWATERING

PART 1: GENERAL

1.01 SCOPE

A. The work of this section consists of providing all labor, materials, and equipment necessary to dewater trench and structure excavations.

B. Disposal of water entering excavation or other parts of the work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02010: Subsurface Conditions

B. Section 02210: Site Grading

C. Section 02223: Trenching, Backfilling, and Compacting

D. Section 02225: Structure Excavation and Backfill

E. Appendix B: Geotechnical Report

1.03 SUBMITTALS

A. In accordance with Section 01300.

B. Two weeks prior to installation of dewatering facilities and commencement of excavation, submit:

1. A dewatering plan prepared and submitted to the Engineer for approval.

2. Drawings and descriptions indicating numbers, locations, arrangements, depths, capacities, and construction details, as applicable, of all dewatering system equipment and components, including standby equipment and components.

3. Methods of disposal of pumped water.

4. Methods of diverting precipitation and surface water away from excavations.

5. Method for collecting and removing precipitation within excavations as necessary.

6. Copies of executed permits necessary to perform work.

1.04 PERMITS

The Contractor shall obtain and comply with all required permits for the dewatering system and operation, disposal of water, and pay all associated fees. Required permits include but are not limited to: Statewide General Order No. 2003-003-DWQ for low threat discharges to land and Central Valley Regional Board Res. R5-2013-0145.

PART 2: MATERIALS

2.01 FACILITIES AND EQUIPMENT

The Contractor shall provide all necessary facilities and equipment for the dewatering operations.

PART 3: EXECUTION

3.01 GENERAL REQUIREMENTS

A. The Contractor shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Dewatering shall commence at an appropriate time prior to commencing excavation and shall be continuous until facilities and structures are completed, backfilled, and, as appropriate, filled with water to prevent damage from hydrostatic uplift and/or floatation.

C. Excavations extending below site groundwater levels, or which encounter perched groundwater within permeable soil layers shall be dewatered. Dewatering of narrow trench excavations that penetrate less than a few feet below the groundwater level and do not encounter loose and/or cohesionless soils may be possible by directing inflow to a sump where water can be removed by a pump. Temporary dewatering of wider, deeper, and/or more extensive excavations may require well points, perimeter trench drains, and/or deep sumps. To help maintain bottom stability of wider, deeper, and/or more extensive excavations, groundwater levels shall be drawn-down a minimum of 3 feet below the lowest portion of the excavation.

D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation and protect temporary excavation slope stability during construction. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock on approved geotextile fabric at no additional cost to the Owner.

3.02 DISPOSAL OF WATER

A. The Contractor shall be responsible to design and control the dewatering operations such that disposal of water does not cause erosion or other damage and such that water to be disposed of is free from silt and other objectionable materials and in compliance with any applicable permit requirements. Settling basins and/or other means shall be used as necessary.

B. Contractor shall utilize applicable construction activity Best Management Practices (BMP) for the project. Refer to "Caltrans Storm Water Quality Handbooks, Construction Site Best Management Procedures Manual", May 2017 or Latest Edition. Groundwater discharges are included in Section NS-2.

C. The Contractor shall be responsible for obtaining a Dewatering General Permit for any dewatering activity, including removal and discharge of groundwater, accumulated rainwater and removing water from cofferdams or diversions, if necessary. Dewatering activities shall comply with the conditions of the Central Valley Regional Water Control Board's General Permit for Dewatering Activities.

3.03 TERMINATION OF DEWATERING

The termination of dewatering operations shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines and sewers. Dewatering devices/features shall either be removed or abandoned in place in accordance with legal regulatory requirements and as approved by the Engineer.

END OF SECTION

SECTION 02210

SITE GRADING

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of excavation, fill placement, and removal and disposal of excess and unsuitable material all as required to establish site grades as shown on the plans. Excavation includes excavation and grading for earthen levees, facilities pad, roadways, areas adjacent to structures, slope rounding, benching, waterways, furrow and interception ditches, and removal of unsuitable material from the roadbed and beneath fill areas.

1.02 QUALITY ASSURANCE

Testing required to determine compliance for the work of this section will be the responsibility of the Owner and at the Owner's expense. The Contractor shall cooperate by rerouting equipment or by temporarily closing the immediate work area being tested. Areas where test results indicate noncompliance shall be corrected before placing additional fill.

1.03 PROJECT CONDITIONS

Maintain fills, slopes, and ditches within the limits of the new construction until final acceptance. Repair areas damaged as a result of storms or construction. Take necessary precautions to prevent the entrance of soils and other materials into streambeds, lakes or water courses.

1.04 RELATIVE COMPACTION TEST

Where relative compaction densities are specified in these specifications, the maximum density shall be determined in accordance with the latest revision of either California Test 216 (California Department of Transportation), ANSI/ASTM 1557, or AASHO T180 and the actual density of in place materials shall be determined in accordance with the latest revision of either California Test 216 or 231, ANSI/ASTM 1556, or ANSI/ASTM 2922. Method selection- shall be made by the Engineer.

PART 2: MATERIALS

2.01 GENERAL

A. Fill material shall be on-site and/or import material, both subject to approval by the Engineer.

B. Material shall be free from detrimental quantities of organic materials and free of all debris, muck, and other unsuitable materials. Frozen material will not be permitted as fill.

2.02 EROSION CONTROL

A. Cut and fill slopes shall be seeded as described in Section 02272.

B. Contractor shall submit a specific plan for controlling runoff from the plant site during the rainy season (October 15 through April 1) and any other time significant rain is forecast. Control shall be by means of silt fences, detention basins, straw bales, earthen berms, or other approved means.

PART 3: EXECUTION

3.01 GENERAL

Finish grades and existing or natural grades in the area adjacent to the structures are indicated on the plans. The Contractor shall do all grading, filling in or excavating as required to completely grade the site to lines and grades shown, and to provide for the indicated drainage. Where finish grade corresponds practically with existing grade, the ground shall be worked up and graded off evenly with existing grade. The grading operation shall generally consist of moving and transporting materials within the area; however, the Contractor shall provide any additional fill material if necessary to complete the site grading to the elevations shown, or to waste any excess material which may result. Clearing and stripping shall be as required in Section 02100.

A. Owner will not be responsible for additional costs associated with variations in elevation, in shrinkage factors and related earthwork quantities.

B. Verify existing grades and conditions are as indicated on drawings prior to commencing.

C. Should indicated conditions conflict with actual conditions and contours, notify the Agency and await their directions before proceeding. Commencement of work indicates acceptance of existing conditions as shown in the plans.

3.02 GROUND SURFACE PREPARATION

Before excavating or placing fill material, complete all clearing and grubbing, and scarify ground surface to provide ample bond between old and new material as per Section 02100.

3.03 PLACEMENT OF FILL

Place fill material in layers not exceeding 8 inches loose measurement. Compact each layer before placing the next layer. As the compaction of each layer progresses, continually level and manipulate to assure uniform moisture and density. Add water to obtain specified moisture content.

3.04 DENSITY REQUIREMENTS

The top 2.5 feet of fill materials or top 0.5 feet of cut that are to support roadway pavements, parking areas, and walks shall be engineered fill compacted to 95 percent of the maximum density. All fill below the top 2.5 feet and all fill not supporting roadways, parking areas, or walks shall be compacted to 90 percent of maximum density. See Geotechnical Report for engineered fill requirements.

3.05 ROCK FILL

A. When excavated material contains more than 25 percent of rock larger than 6 inches in greatest diameter and cannot be placed in 8-inch layers, such material may be placed in layers not exceeding in thickness the approximate size of the larger rocks, but not greater than 2 feet or- as recommended in the Geotechnical Report

B. Level and smooth each layer with suitable leveling equipment by distributing spalls and finer fragments or earth. The lifts shall not be constructed above an elevation 2 feet below the finish subgrade. Construct upper 2 feet of embankment with suitable material smoothed and placed in layers not exceeding 8 inches in loose thickness and compacted as specified above.

C. Even though the thickness of layers is limited as provided above, the placing of individual rocks and boulders greater than 24 inches in diameter will be permitted, provided that when placed, they do not exceed 48 inches in height and provided they are carefully distributed, with the interstices filled with finer material to form a dense and compact mass as detailed in the Geotechnical Report.

D. Route hauling and leveling equipment over each layer of the fill to make use of the compactive effort afforded thereby. In addition, at least one compactor shall be in continuous operation during placement.

3.06 DITCHES

Construct drains, channels, and inlet and outlet ditches for culverts as shown or as directed. Round and trim ditch slopes neatly to line. Final flow line grade shall be reasonably uniform to provide free drainage without puddling.

3.07 SLOPE FINISHING

Leave earth slopes with a roughened but reasonably uniform surface without noticeable breaks. The final surface shall be similar to that obtained by using a farm disk or harrow parallel to the roadway. Blend slopes smoothly with the adjacent terrain. Grading shall provide for drainage away from all sides of structures.

3.08 DISPOSAL OF EXCESS MATERIAL

Excess material shall be disposed of off-site at the Contractor's expense.

END OF SECTION

Section 02221

UTILITY TRENCHING & BACKFILLING

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of trenching and backfilling for the construction and installation of pipelines, conduits and cables. All trenching will be open cut. It includes all clearing and grubbing, drilling and blasting, construction of cribbing and cofferdams, dewatering, incidental work, and providing specified backfill.

1.02 QUALITY ASSURANCE

A. All compaction testing and gradation analysis will be arranged and paid for by the City. Contractor shall be present when samples of bedding, select backfill, and backfill materials are gathered for analysis.

B. Where relative compaction densities are specified in these specifications, the maximum density shall be determined in accordance with the latest revision of either California Test 216 (California Department of Transportation), ANSI/ASTM 1557, or AASHO T180 and the actual density of in-place materials shall be determined in accordance with the latest revision of either California Test 216 or 231, ANSI/ASTM 1556, or ANSI/ASTM 2922. Method selection- shall be made by the Engineer.

C. Engineer will perform at least one test within each backfill material zone (BD, SB, BF). Testing at more frequent intervals may be performed at the discretion of the Engineer.

1.03 SUBMITTALS: In accordance with Section 01300.

Written description of barricading, shoring, cribbing, bracing, and sloping precautions are found in Section 02400 Sheeting, Waling, and Shoring.

1.04 PROJECT CONDITIONS

A. Obtain all required permits and licenses before installing utilities under existing roads and follow the rules and requirements of the authority having jurisdiction.

B. Arrange construction sequences to provide the shortest practical time that the trenches will be open to avoid hazard to the treatment plant staff, subcontractors, and public, and to minimize the possibility of trench collapse.

1.05 EXCAVATION CLASSIFICATION

Refer to specification 02200 for excavation classification and specification 01354 for hazardous materials requirement with regards to on-site soils.

1.06 HAND EXCAVATION

Engineer will direct the performance of hand excavation within the drip line of selected trees shown on the drawings within the limits of cuts but not shown to be removed.

PART 2: MATERIALS

2.01 GENERAL

All backfill material shall be approved before use and be free of cinders, ashes, ice, frozen soil, large hard clods, organic debris, or other deleterious items. Trench excavation materials may be used as approved.

2.02 BEDDING AND BACKFILL

Materials used in bedding and backfill, as shown in trench details, are defined as follows:

A. Bedding (BD): Materials shall be predominantly sand and gravel, having a plasticity index less than 6. Bedding may be omitted if, in the opinion of the Engineer, the excavated trench bottom will adequately support and not damage the utility line.

1. BD-1: Gradation as follows:

Sieve size	Percent Passing
No. 4	100
No. 8	55 - 85
No. 40	15 - 30

2. BD-2: Gradation as follows:

Sieve Size	Percent Passing
½-inch	100
No. 4	50 - 80
No. 40	10 - 25

3. BD-3: Gradation as follows:

Sieve Size	Percent Passing

1½-inch	100
½-inch	45 - 75
No. 40	5 - 15

B. Select Backfill (SB): Materials shall be predominantly sand and gravel, having a plasticity index less than 6.

1. SB-1: Gradation as follows:

Sieve Size	Percent Passing
No. 4	100
No. 8	55 - 85
No. 40	15 - 30

2. SB-2: Gradation as follows:

Sieve Size	Percent Passing
½-inch	100
No. 4	50 - 80
No. 40	10 - 25

3. SB-3: Gradation as follows:

Sieve Size	Percent Passing
¾-inch	100
3/8-inch	55 - 80
No. 40	10 - 25

C. Backfill (BF):

1. BF-1: Materials shall be predominantly sand and gravel, having a plasticity index less than 6, and graded as follows:

Sieve Size	Percent Passing
1½-inch	100
½-inch	45 - 75
No. 40	10 - 25

2. BF2: Soils that contain no rock larger than 3 inches at greatest dimension. If expansive clays are present, such content shall not exceed one- -third of the material by volume, and shall be well mixed with non-cohesive soils.

2.03 AGGREGATE BASE-- PIPE BASE AND PIPE ZONE MATERIAL ALTERNATE

Pipe zone material shall be ¾-inch Class 2 Aggregate Base conforming to Caltrans Standard Specifications 26-1.02.

2.04 LIGHTWEIGHT INSULATING (PERLITE) CONCRETE PIPE BEDDING MATERIAL

Buried piping with "DSH" service shall be installed with a minimum of 6 inches of lightweight (perlite) concrete bedding all around the pipe. Perlite concrete shall be as specified in Section 03100.

2.05 TRENCH ZONE MATERIAL

Trench zone material shall consist of material conforming to engineered fill in accordance with Section 02210 and the Geotechnical Report (Appendix B)

2.06 REFILL FOR FOUNDATION STABILIZATION

Refill shall meet the material requirements specified for pipe zone. As an alternative, crushed rock, enveloped in geotextile fabric may be utilized.

2.07 CONCRETE FOR PIPE ENCASEMENT AND THRUST BLOCKS

A. Concrete for pipe encasement and thrust blocks shall be Class C per Section 03100, unless otherwise shown in the drawings.

B. Provide thrust blocks at fittings in pipe having rubber gasket bell and spigot or unrestrained mechanical joints. Provide thrust blocks at all tees and elbows 45° and greater, or as noted on contract plans and in the general or specific pipe specifications.

C. See the details in the drawings for thrust block sizes. Install thrust blocks based on the test pressures given in the drawings.

2.08 WATER FOR COMPACTION

Water for compaction shall be clean and free of oil, acids, salts, and other deleterious substances. Water shall be supplied by the Contractor at no additional expense to the Owner. Reclaimed water may be used for compaction. Reclaimed water may be obtained from the City's WWTP at no cost to the Contractor. The Contractor shall coordinate with the Engineer for the use of the water, shall provide all necessary labor and equipment to extract the water, and shall be responsible for the repair of any damage to the existing facilities which can be attributed to this operation.

PART 3: EXECUTION

3.01 TRENCH EXCAVATION

A. Trenching Guidelines: Excavate the trench to the approximate level of the top of the utility line to be installed, using adequate trench width and side slopes to safely accommodate worker access. Continue excavating for the utility line, to a width not greater than is shown on the appropriate trench detail.

1. Rocky Trench Bottom: Where ledge rock, hard pan, boulders, or sharp-edged materials are encountered, -over excavate- a minimum depth of 6 inches below the bottom of the utility exterior wall to permit adequate bedding preparation. The installed utility shall have at least 6 inches of clearance from any rock protrusion.

2. Unstable Trench Bottom: Secure approval of depth of over excavation and stabilization method. For wet trench construction, use approved method of dewatering through diversion, damming and pumping, well points, or underdrain systems. Dispose of removed fluidized materials as approved. Use BD-3 material to build a suitable foundation to within 4 inches of the pipe. Compact layers to 95 percent of maximum density in not greater than 6-inch layers. Do not proceed with utility installation until wet trench and unstable conditions are under control.

3. Hand Excavation: Perform hand excavation of trenches dug within the drip line of selected trees as shown. Carefully excavate around all roots 2 inches in diameter and larger to insure against damage.

4. Paved Areas: Cut existing pavement full depth to a true line before excavation, as shown, and maintain the edge suitable for repaving. Pavement removed shall not be used as backfill.

5. Lawn Areas: Where trenches cross established lawn areas, remove turf with approved sod cutting equipment. Store and maintain the removed sod for later replacement. Cut to the lines shown or as directed.

3.02 SHORING AND SHEETING

B. Construct and maintain all shoring, sheeting, and slope layback necessary to protect the excavation, as needed for the safety of the employees and as required by applicable State and Federal law.
C. For trenches over 5 feet deep, provide suitable barricades for worker protection. When work area is left open and unattended by Contractor, provide suitable barricades for public safety, regardless of trench depth.
D. For trenches over 4 feet deep, provide suitable exit means in accordance with applicable provisions of OSHA.
E. Remove all sheeting and shoring when safe to do so.

3.03 PIPE BEDDING

Pipe bedding shall conform to the trench details shown on the drawings and the following:

F. Bedding shall provide uniform and continuous support along the barrel of the pipe. Blocking of the pipe is not permitted.

G. Loose material shall be removed from the trench bottom and replaced with imported material.
H. Where rocky, unyielding, or unsuitable foundation material is encountered, the subgrade shall be excavated a minimum of 6 inches below the pipe and the trench width shall be increased a minimum of 12 inches. The over-excavation shall be replaced with imported material per paragraph 3.01 A.2.
I. Where the trench bottom is soft, yielding, or unstable, the trench bottom shall be over-excavated. Three-quarter inch crushed rock shall be placed in the trench to provide a stable foundation. The rock is in addition to the required pipe bedding used in the pipe zone.
J. Bell holes shall be excavated per manufacturer's recommendations. The minimum depth of bedding material shall be provided under the bell. Care shall be taken to ensure that the bell hole is no larger than necessary to accomplish proper joint assembly.

3.04 PIPE ZONE BACKFILL

Pipe zone backfill shall conform to the trench details shown on the drawings and the following:

K. Extreme care shall be taken when consolidating the backfill around the pipe zone. For pipe 12 inches in diameter and smaller, no more than one-half of the pipe shall be covered prior to shovel slicing the haunches of the pipe. For pipe greater than 12 inches in diameter, no more than the lesser of 6 inches or one-third of the pipe shall be covered prior to shovel slicing. Sufficient care shall be taken to prevent movement of the pipe during shovel slicing. Shovel slicing shall be witnessed by the field inspector prior to shading the pipe.

L. Compaction equipment shall not make direct contact with the pipe.
M. Where the pipe is to be installed below historic groundwater levels or where the trench is subject to inundation, crushed rock material shall be placed to the crown of the pipe.

3.05 BACKFILLING

A. Compaction: Use vibratory compactors for sands and gravels (Non cohesive soils). Use mechanical tampers for sand and gravel containing a significant portion of fine-grained material, such as silt and clay (cohesive soils). Hand tamp around pipe or cable to protect the lines until adequate cushion is attained-.

N. Bedding: Compact the specified material to 90 percent of maximum density to the finished utility grade.
O. Select Backfill: Place select backfill to 12 inches above the utility line by hand placement in not more than 6-inch layers. Compact each layer to 90 percent of maximum density.
P. Backfill: Place and compact the specified materials as follows:

1. Vehicular Traffic Areas: Fill and compact in 8-inch maximum layers to 95 percent of maximum density.

2. Pedestrian and Lawn Areas: Fill and compact to 90 percent of maximum density.

3. Nontraffic Areas: Fill and compact to 85 percent of maximum density.

3.06 SURFACE FINISH WORK

A. Paved Areas: Replace removed paving and base course with new material of equal or better quality and of the same texture and color as the adjacent paved areas. Saw cut pavement edge to a true line and broom as needed prior to paving.

B. Lawn Areas: Prepare the area for proper relaying of the previously removed sod. Remove trench and backfill materials from adjacent lawn areas to permit unhindered growth of grasses and safe operation of mowing equipment. Replace sod. Sod and adjacent lawn areas that do not reestablish at the commencement of the next growing season shall be replaced at no additional expense to the City.

C. Open and Seeded Areas: Grade all disturbed areas to a finish ordinarily obtained from the blade grader, with no abrupt changes in grade or irregularities that will hold water.

D. Drainage Ditches: Restore drainage ditches to appropriate line and grade, using approved surface erosion prevention techniques.

E. Cleanup: Prior to final inspection and acceptance, remove all rubbish and excess material for disposal as approved, and leave area in a neat, satisfactory condition.

END OF SECTION

SECTION 02223

TRENCHING, BACKFILLING, AND COMPACTING

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of trenching and backfilling for the construction and installation of pipelines, conduits, and cables. All trenching will be open cut, unless otherwise approved in writing. It includes all clearing and grubbing, trenching or tunneling, construction of cribbing and cofferdams, dewatering, incidental work, and providing specified backfill.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01666: Testing of Gravity Sewer Lines and Manholes

B. Section 02010: Subsurface Conditions

C. Section 02100: Demolition, Clearing, Grubbing, and Stripping

D. Section 02140: Dewatering

E. Section 02200: Earthwork

F. Section 02513: Asphalt Concrete Paving

G. Section 03100: Concrete

H. Appendix B: Geotechnical Investigation

1.03 SUBMITTALS

A. Submit a copy of a report from a testing laboratory verifying that backfill material conforms to the specified gradations of characteristics for granular material, imported sand, rock refill for foundation stabilization, and water.

B. Submit method of compaction in pipe zone including removal sequence of shoring where used.

C. Provide written description of barricading, shoring, cribbing, bracing, and sloping precautions.

D. Upon request, the following items shall be submitted and approved by the engineer:

1. Test results showing gradation, durability, and sand equivalent of pipe zone material.

2. The Annual or Project Permit as issued by the Division of Occupational Safety and Health (OSHA) for excavations five (5) feet or more in depth as required by Cal-OSHA, including any structural excavations and shoring plans.

1.04 PROJECT CONDITIONS

A. Obtain all required permits and licenses before installing utilities under existing roads, and follow the rules and requirements of the authority having jurisdiction.

B. Arrange construction sequences to provide the shortest practical time that the trenches will be open to avoid hazard to the treatment plant staff, subcontractors, and public, and to minimize the possibility of trench collapse.

1.05 TESTING FOR COMPACTION

A. The Owner will test for compaction at locations determined by the Owner.

B. Relative compaction is defined as the ratio, in percent, of the as-compacted dry density to the laboratory maximum dry density. The laboratory maximum dry density is defined in accordance with ASTM D 1557, latest edition.

C. Where compaction tests indicate a failure to meet the specified compaction, the Owner will take additional tests every 50 feet in each direction until the extent of the failing area is identified. Rework the entire failed area until the specified compaction has been achieved.

1.06 STREET ZONE

The street zone includes the asphalt concrete and aggregate base pavement section placed over the trench backfill.

1.07 TRENCH ZONE

The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the street zone in paved areas or to the existing surface in unpaved areas.

1.08 PIPE ZONE

The pipe zone shall include the full width of trench from the bottom of the pipe or conduit to a horizontal level above the top of the pipe, as shown on the contract drawings. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipes to a horizontal level above the top of the highest or topmost pipe.

1.09 PIPE BASE OR BEDDING

The pipe base or bedding shall be defined as a minimum 6-inches thick layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width in which the pipe is bedded.

PART 2: MATERIALS

2.01 GRANULAR MATERIAL FOR BACKFILL - STREET ZONE

Granular material or granular soil for backfill used above the pipe zone shall be ¾ -inch – Class 2 Aggregate Base conforming to Caltrans Standard Specification 26-1.02.

The sand equivalent shall be 30 minimum. The durability index shall be 35 minimum.

2.02 PIPE BASE AND PIPE ZONE

A. Graded sand used for the pipe base and pipe zone shall be free of clay or organic material and have the following gradation:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
3/8-INCH	100
No. 4	92 – 100
No. 8	90 - 100
No. 16	80 - 100
No. 30	65 – 100
No. 50	40 - 80
No. 100	0 - 40
No. 200	0 – 12

Imported sand shall have a sand equivalent not less than 28 per ASTM D 2419.

2.03 TRENCH ZONE MATERIAL

Trench zone material shall conform to engineered fill, in accordance with Section 02200.

2.04 CEMENT SLURRY - -PIPE BASE AND PIPE ZONE ALTERNATIVE

Cement slurry backfill shall consist of Type I or II Portland cement, imported sand, and sufficient water for workability, per Caltrans Standard Specification 19-3.02E. The mix shall produce a minimum 28-day strength of 50 PSI and 1 x 10^{-6} cm/sec permeability. Submit a mix design and confirming test results per Section 01300.

2.05 REFILL FOR FOUNDATION STABILIZATION

¾ - inch crushed rock shall be used in areas where pipelines extend into loose medium dense sands below the water table.

2.06 CONCRETE FOR PIPE ENCASEMENT AND THRUST BLOCKS

A. Concrete for pipe encasement and thrust blocks shall be Class C per Section 03100, unless otherwise shown in the drawings.

B. Provide thrust blocks at fittings in pipe having rubber gasket bell and spigot or unrestrained mechanical joints as directed by the Engineer. Provide thrust blocks at all unrestrained "Tees" and elbows 45° and greater, or as noted on contract plans and in the general or specific pipe specifications.

C. Size thrust block bearing area for 900 PSF. Size thrust blocks based on the test pressures provided in the contract documents.

2.07 WATER FOR COMPACTION

Water for compaction shall be clean and free of oil, acids, salts, and other deleterious substances. Water shall be supplied by the Contractor at no additional expense to the Owner. . The Contractor shall coordinate with the Engineer for the use of the water shall provide all necessary labor and equipment to extract the water and shall be responsible for the repair of any damage to the existing facilities which can be attributed to this operation.

PART 3: EXECUTION

3.01 COMPACTION REQUIREMENTS

Unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:

A. Pipe Base: 95% relative compaction.

B. Pipe Zone: 95% relative compaction.

C. Backfill in Trench Zone not Beneath Paving or Aggregate Base Access Roadways: 90% relative compaction.

D. Backfill in Trench Zone to Street Zone in Paved Areas or Within Limits of Aggregate Base Roadways: 95% relative compaction.

E. Backfill in Street Zone in Paved Areas or within Limits of Aggregate Base Roadways: 95% of relative compaction.

F. Refill for Foundation Stabilization: 95% relative compaction.

G. Refill for Over excavation: 95% relative compaction.

3.02 MATERIAL REPLACEMENT

Remove and replace any trenching and backfilling material which does not meet the specifications, at the Contractor's expense.

3.03 SLOPING, SHEETING, SHORING, AND BRACING OF TRENCHES

Trenches shall have sloping, sheeting, shoring, and bracing conforming with 29CFR1926, Subpart P – Excavations, CAL/OSHA requirements, and the General Conditions.

3.04 SIDEWALK, PAVEMENT, AND CURB REMOVAL

Cut bituminous and concrete pavements regardless of the thickness and curbs and sidewalks prior to excavation of the trenches with a pavement saw or pavement cutter. Width of the pavement cut shall be at least equal to the required width of the trench at ground surface. Haul pavement and concrete materials from the site. Do not use for trench backfill.

3.05 TRENCH WIDTHS

Trench widths in the pipe zone shall be as shown in the drawings. If no details are shown, maximum width shall be 24 inches greater than the pipe outside diameter. Comply with 29CFR Part 1926 Subpart P – Excavations. Trench width at the top of the trench will not be limited except where width of excavation would undercut adjacent structures and footings. In such case, width of trench shall be such that there is at least 2 feet between the top edge of the trench and the structure or footing.

3.06 TRENCH EXCAVATION

Excavate the trench to the lines and grades shown in the drawings with allowance for pipe thickness, sheeting and shoring if used, and for pipe base or special bedding. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade at no additional cost to the Owner with foundation stabilization material. Place the refilling material over the full width of trench in compacted layers not exceeding 6-inches deep to the established grade with allowance for the pipe base or special bedding.

The trench shall be excavated to a minimum depth of 6 inches below the bottom of the pipe. The sides of the trench shall be excavated and maintained as nearly vertical as practical.

3.07 DEWATERING

A. Provide and maintain means and devices to remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipelaying, during the laying of the pipe, and until the backfill at the pipe zone has been completed. These provisions apply at all times. Dispose of the water in a manner to

prevent damage to adjacent property and in accordance with regulatory agency requirements. Do not drain trench water through the pipeline under construction. Do not allow groundwater to rise around the pipe until the jointing compound has set hard. See Section 02140 – Dewatering.

B. Dewater in accordance with Section 02140.

3.08 LOCATION OF EXCAVATED MATERIAL

During trench excavation, place the excavated material only within the working area. Do not obstruct any roadways or streets. Conform tothe federal, state, and local codes governing the safe loading of trenches with excavated material. All trenches in publicly accessible areas shall be backfilled at the end of each day's operation. Trench patching with asphalt concrete shall be completed within 24 hours of trench backfill.

3.09 LENGTH OF OPEN TRENCH

Limit the length of open trench to 500 feet in advance of pipelaying or amount of pipe installed in one working day, whichever is less, and not more than 500 feet in the rear of pipelaying, except as modified by encroachment permit requirements. At the end of each working day, the trench shall be backfilled to match the existing surface.

3.10 TRENCH EXCAVATION IN BACKFILL AND EMBANKMENT AREAS

Construct trench excavation for pipe, pipes, or conduit in backfill or embankment areas in accordance with the following procedures:

A. Construct and compact the embankment to an elevation of 1-foot minimum over the top of the layer of the largest pipe or conduit to be installed.

B. Excavate trench in the compacted backfill or embankment. Place cement slurry in the pipe base and pipe zone. Compact backfill above the pipe zone to the relative compaction required for trench zone backfill.

3.11 FOUNDATION STABILIZATION

A. After the required excavation has been completed, the Owner and/or Agency will inspect the exposed subgrade to determine the need for any additional excavation. It is the intent that additional excavation be conducted in all areas within the influence of the pipeline where unacceptable materials exist at the exposed subgrade. Over excavation shall include the removal of all such unacceptable materials that exists directly beneath the pipeline to the required trench width and to the depth required. Backfill the trench to subgrade of pipe base with refill material for foundation stabilization. Place the foundation stabilization material over the full width of the trench and compact in layers not exceeding 6-inches deep to the required grade. Foundation stabilization work shall be executed in accordance with a change order.

B. Refill used by the Contractor for his convenience will not receive any additional payment.

3.12 INSTALLING BURIED PIPING

A. Backfill per the detailed piping specification for the particular type of pipe and per the following.

B. Handle pipe in such a manner as to avoid damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

C. Inspect each pipe or fitting prior to placing into the trench. Inspect the interior and exterior protective coatings. Patch damaged areas in the field with material recommended by the protective coating manufacturer. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after installation.

D. If the pipeline is designed for use as reclaimed water, the pipe shall be identified as such in one of the following manners:

E. Pipelines designated on the construction drawings as "Reclaimed Water" shall be identified as such prior to placement in the trench using one of the following methods:

1. Furnish and install purple pipe (applicable to PVC pipe only).

2. Wrap the pipeline with polyethylene wrap, purple in color. Secure circumferentially at intervals not exceeding 2 pipe diameters with duct tape.

3. Wrap the pipeline with metallic tape, 12-inches minimum width, purple in color labeled "Reclaimed Water". Wrap spirally around the pipe throughout the entire pipe length, with a pitch such that no gap greater than 12-inches exists longitudinally down the pipe. Secure circumferentially at intervals not exceeding 2 pipe diameters with duct tape.

4. Coat each pipe segment with pigmented polyurethane enamel, purple in color. Allow to cure, dry to the touch prior to installation in the pipe trench.

Install a 12-inch-wide identification/locator strip of tape, purple in color, labeled "Reclaimed Water". Tape shall be placed continuously in the trench at the top of the Pipe Zone.

F. Grade the bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness and bedding depth. Remove hard spots that would prevent a uniform thickness of bedding. Place the specified thickness pipe base material over the full width of trench. Grade the top of the pipe base ahead of the pipelaying to provide firm, continuous, uniform support along the full length of pie, and compact to the relative compaction specified herein. After laying each section

of the pipe, check the grade and alignment and correct any irregularities prior to laying the next joint.

G. Excavate bell holes at each joint to permit proper assembly and inspection of entire joint. Fill the area excavated for the joints with the bedding material specified or detailed in the drawings.

H. When installing pipe, do not deviate more than 1-inch from line or 1/4 –inch from grade. Measure elevation at the pipe invert. The Contractor shall verify pipe grade at intervals of not more than 80 feet, in the presence of the Owner's Representative.

I. After pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, in maximum 6-inch lifts, keeping the level of backfill the same on each side. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or compacted areas are left beneath the pipe. Use particular care in placing material on the underside of pipe to prevent lateral movement during subsequent backfilling.

J. For pipe sizes greater than 12-inches in diameter, no more backfill material than the lesser of 6-inches or 1/3rd of the pipe diameter shall be placed prior to shovel slicing. Sufficient care shall be taken to prevent movement of the pipe during shovel slicing. Shovel slicing shall be witnessed by the Field Inspector and/or Geotechnical Engineer.

K. Compact each lift to the relative compaction specified herein.

L. Push the backfill material carefully onto the backfill previously placed in the pipe zone. Do not permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pie. Do not operate heavy equipment over the pipe until at least 3 feet of backfill has been placed and compacted over the pipe.

M. When pipelaying is not in progress, including the noon hours, close the open ends of pipe. Do not allow trench water, animals, or foreign material to enter the pipe.

N. Remove and dispose of all water entering the trench during the process of pipelaying. Keep the trench dry until the pipelaying and jointing are completed.

3.13 BACKFILL COMPACTION

Compact per the detailed piping specification for the particular type of pipe and per the following:

A. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction or hand tamping. Do not use high impact hammer-type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe. Ponding or jetting is not allowed.

B. Compact material placed within 12-inches of the outer surface of the pipe by hand tamping only.

C. Do not use any axle-driven or tractor-drawn compaction equipment within 5 feet of building walls, foundations, or other structures.

3.14 CONTROLLED LOW STRENGTH MATERIAL (CLSM) BACKFILL

When Controlled Low Strength Material is utilized, pipe shall be supported by mounding imported backfill material or sandbags filled with imported backfill material. Material shall conform to Section 03110.

END OF SECTION

SECTION 02225

STRUCTURE EXCAVATION AND BACKFILL

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of all structure excavation and backfill required to complete the work and furnishing select or imported backfill. It includes disposal of surplus or unsuitable material.

1.02 QUALITY ASSURANCE

Evaluation of all fill materials and testing required to determine compliance for the work of this section will be the responsibility of the Owner and at the Owner's expense. The Contractor shall cooperate by rerouting equipment or by temporarily closing the immediate work area being tested. Areas where test results indicate noncompliance shall be corrected before placing additional backfill.

1.03 SUBMITTALS

Upon request, the following items shall be submitted and approved by the engineer:

1. Test results showing gradation, durability, and sand equivalent of pipe zone material.

2. The Annual or Project Permit as issued by the Division of Occupational Safety and Health (OSHA) for excavations five (5) feet or more in depth as required by Cal-OSHA, including any structural excavations and shoring plans.

1.04 PROJECT CONDITIONS

Take necessary precautions to prevent the entrance of soils and other materials into streambeds, lakes, or water courses.

1.05 RELATIVE COMPACTION TEST

A. The Owner will test for compaction at locations determined by the Owner.

B. Relative compaction is defined as the ratio, in percent, of the as-compacted dry density to the laboratory maximum dry density. The laboratory maximum dry density is defined in accordance with ASTM D 1557, latest edition.

C. Where compaction tests indicate a failure to meet the specified compaction, the Owner will take additional tests every 50 feet in each direction until the extent of

the failing area is identified. Rework the entire failed area until the specified compaction has been achieved.

PART 2: MATERIALS

2.01 ENGINEERED FILL

See Section 02210 and the Geotechnical Report for material requirements.

2.02 CRUSHED ROCK

Material shall be crushed rock of one-inch (1") maximum size, with no material passing a Number four (#4) sieve.

2.03 AGGREGATE BASE

Aggregate base shall be Class 2 aggregate base, ¾" maximum as specified in Section 26 of the California Department of Transportation Standard specifications.

2.04 DRAIN ROCK

Drain rock shall be Class 1, Type B permeable material as specified in Section 68 of the California Department of Transportation Standard specifications.

2.05 STRUCTURAL GEOTEXTILE FABRIC

Geotextile fabric under structures shall be Amoco 4551 or equal.

2.06 FILTER FABRIC

Filter fabric shall be non-woven geotextile fabric, Amoco 4550, or equal.

PART 3: EXECUTION

3.01 CLEARING

Perform clearing operations in accordance with Section 02100.

3.02 STRUCTURAL EXCAVATION

A. General: All excavation for structures shall be done to the dimensions and levels indicated on the drawings or specified herein.

Excavation is unclassified - The Contractor shall complete all excavations regardless of the type of materials encountered. The Contractor shall make its own estimate of the kind and extent of the various materials, which will be encountered in the excavation.

1. Under all structures, the Contractor shall:

   a. Excavate to subgrade, remove and dispose of organic material and unsuitable soils. Excavation shall be made to a minimum of 3 feet outside the lines of the structure to be constructed therein as may be required for proper working methods, the erection of forms, and the protection of the work. The sides of excavations for structures shall be sufficient to leave at least 1.5 feet clear, as measured from the extreme outside of form work on the structure, as the case may be. Care shall be taken to preserve the foundation surfaces shown on the drawings in an undisturbed condition. If the Contractor excavates or disturbs the foundation surfaces shown on the drawings or specified herein without written authorization of the Engineer, he shall replace at his expense such foundations with compacted gravel foundation fill or other material approved by the Engineer in a manner which will show by test an equal bearing strength with the undisturbed foundation material.

   b. Scarify the surface to a minimum depth of 12-inches, bring the moisture content to optimum plus 2 percent or above, and compact to 90 percent minimum relative compaction.

   c. Place engineered fill in 8-inch maximum lifts to obtain subgrade elevations. Compaction efforts shall conform to the recommendations of the Geotechnical report.

2. Under all pavements, the Contractor shall:

   a. Excavate to below subgrade, remove and dispose of organic material and unsuitable soils.

   b. Scarify the surface a minimum depth of 12-inches, bring the moisture content to optimum plus 2 percent or above and compact to 95 percent minimum relative compaction.

   c. Place engineered fill in 8-inch maximum lifts to obtain subgrade elevations. Compaction efforts shall conform to the Geotechnical Report.

3. Under all embankments, the Contractor shall:

   a. Excavate to below subgrade, remove and dispose of organic material and unsuitable soils.

   b. Scarify the surface a minimum depth of 12-inches, bring the moisture content to optimum plus 2 percent or above and compact

to 95 percent minimum relative compaction.

c. Place engineered fill in 8-inch maximum lifts to obtain subgrade elevations. Compaction efforts shall conform to the recommendations of the Geotechnical Report.

Care shall be taken to preserve the foundation surfaces shown on the drawings in an undisturbed condition. If the Contractor excavates or disturbs the foundation surfaces shown on the drawings or specified herein without written authorization of the Engineer, he shall replace at his expense such foundations with compacted gravel foundation fill or other material approved by the Engineer in a manner which will show by test an equal bearing strength with the undisturbed foundation material.

B. Bracing, Sheeting, and Shoring: Care shall be exercised in excavating for lower footings not to disturb bearing under higher adjacent footings or structures. Existing structures and pipework shall be adequately braced and cared for so that no damage will result. The Contractor shall submit structural calculations and drawings signed and sealed by a civil engineer registered in the State of California showing members, connections, and anchorage of the proposed bracing, sheeting, and shoring. The Contractor shall provide suitable sheeting and shoring, where necessary, for protection of the excavations. All such sheeting and shoring shall be removed unless otherwise specifically authorized.

C. Unsuitable Materials: To suit field conditions, excavation below the depths shown may be ordered, but changes may only be made as directed. Soft, spongy, or unsuitable bearing material of any kind shall be entirely removed down to solid bearing soil and replaced with an engineered fill as specified herein. In such an event only the excess excavation and fill will be paid for as extra work.

D. Dewatering: Any water that may be encountered or that may accumulate in excavations shall be removed and kept out by pumping or other approved methods, and all construction shall be carried out in the dry. Water shall be kept down until structures are complete to above water, safe from uplift and horizontal water pressure and the backfill has been placed. Dewatering shall be in accordance with Section 02140.

E. Approval of Excavation: The Contractor shall notify the Engineer when excavation for a structure is complete and no forms, reinforcing steel or concrete, shall be placed until the excavation has been approved by the Engineer. Once the excavation is approved, the Contractor must protect the work from flooding or groundwater uplift.

F. Disposal of Waste Excavation: Excavated material determined by the Engineer to be unsuitable, or in excess of the amounts required for backfill shall be disposed on-site as shown on the drawings and as directed by the Engineer at no additional

cost to the Owner.

3.03 STRUCTURAL FOUNDATIONS

Foundations and footings shall rest on suitable undisturbed soil or compacted subgrade. Over subgrade Contractor shall install a layer of aggregate as shown on the drawings. The aggregate layer shall be Class 2 aggregate base, completely encase aggregate layer in structural fabric (Amoco 4551 or equal).

3.04 ENGINEERED FILL

A. General: All fill under structures, pavements, embankments, and at other locations where indicated on the drawings shall be made using engineered fill sub-base, carefully controlled and compacted on a prepared surface.

B. Surface Preparation: The surface on which fill is to be placed shall be free of all vegetation, debris, or other objectionable material, and all large roots shall be grubbed out to a depth of at least 2 feet below footing, slab, or pavement elevations and 5 feet beyond the limits of the proposed improvements. The surface shall be scarified to a depth of 12 inches, brought to a moisture content as recommended in the Geotechnical Report. It may be necessary to adjust the moisture content of the subgrade soil by watering or aeration to bring the moisture content of the soil near optimum in order that the specified densities can be obtained.

C. Placement of Fill

1. Fill materials shall be spread in a maximum of 8-inch lifts and shall have a uniform moisture content that will provide the specified dry density after compaction. If necessary to obtain uniform distribution of moisture, water shall be added to each layer by sprinkling and the soil disced, harrowed, or otherwise manipulated after the water is added. If the material is too wet, the moisture content shall be reduced as necessary by spreading and aerating.

2. Field density tests shall be used to check the compaction of the fill materials. Sufficient tests shall be made on each layer by the Engineer to assure adequate compaction throughout the entire area. If the dry densities are not satisfactory, the contractor will be required to increase the weight of the compaction equipment or the number of passes as required to produce the specified densities.

3. Where trenches must be excavated in Engineered Fill these trenches shall be backfilled with the fill materials excavated. The backfill shall be placed in 6 inch layers and each layer compacted with pneumatic tampers to provide densities as specified above. Backfill placed adjacent to walls shall be placed in a similar manner to that specified for backfill in excavated

trenches.

4. No fill shall be placed during weather conditions which will alter the moisture content of the fill materials sufficiently to make adequate compaction impossible. After placing operations have been stopped because of adverse weather conditions, no additional fill material shall be placed until the last layer compacted has been checked and found to be compacted to the specified densities.

3.05 BACKFILL AGAINST STRUCTURES

A. Material for filling and backfilling around structures shall be free from sod, large lumps, boulders, or rocks, roots, brush or other objectionable material, and shall be obtained from required excavations insofar as practicable. Should the material available from excavation be insufficient or unsuitable for the required use, the Contractor shall furnish and place suitable material. Do not place backfill against newly constructed concrete structures for a period of 14 days unless authorized by the Engineer. Hand-held compactors shall be used for backfill against concrete walls within a horizontal distance of H/2 of the structure, where H is defined as the vertical height of the backfill above the foundation. Backfill shall be placed in even, uniform lifts around the structure.

1. No material shall be deposited against cast-in-place concrete structures until the concrete has reached a compressive strength of at least 2,500 pounds per square inch (psi).

2. Backfill within five (5) feet of a structure shall reach at least 95% relative compaction.

3. Structural backfill beyond five (5) feet of the structure shall reach at least 90% relative compaction.

4. Gravel base of any structure shall reach 95% relative compaction

5. Compaction equipment shall be carefully operated near structures to prevent displacement or damage to said structures. Structural fill is to be placed and compacted in uniform layers around all sides of the structure.

END OF SECTION

SECTION 02229

UTILITY LINE MARKING

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of furnishing and installing utility line marking, identifying devices for valves, and underground warning tape for buried utilities.

1.02 SUBMITTALS

A. In accordance with Section 01300.

B. Samples: 24-inch strips of tape, surface markers, and valve tags.

C. Certification that the materials used in the tape fabrication meet the requirements of this section.

D. Submit a complete schedule of all surface markers and valve box identification tags.

PART 2: MATERIALS

2.01 MARKING TAPE

A. Standard marking tape

B. Imprint: 3/4-inch or larger bold black letters.

C. Legend: The buried utility line tape shall be identified with imprint such as "CAUTION: SEWER LINE BELOW" and the identification repeated on approximately 24-inch intervals.

D. Detectable marking and warning tape shall be as manufactured by Christy's of Wheaton, Illinois or Griffolyn Company, Inc. of Houston, Texas, or approved equal.

2.02 SURFACE MARKERS

A. Location Stakes: A list of approved off-site location stakes include:

1. Carsonite #375 (as distributed by Berntsen International SURV-KAP Inc., or equal.)
2. 4" x 5" with anchor barb kit

B. Caution Labels:

1. Caution stickers attached -- #CW-112 and organization decal #P101
2. Nevada County – Call Before Digging – (530) 265-1411 or 1(888) 832-1411

PART 3: EXECUTION

3.01 MARKING TAPE

A. Install tape in backfill directly over each buried utility line, directly above the pipe zone.

B. Where utilities are buried in a common trench, identify each line by a separate warning tape. Bury tapes side by side directly over the applicable line.

3.02 TRACER WIRE

A. Install underground No. 12 tracer wire with marking tape as specified in Section 3.01 and 3M DBY or King direct splice bury kits.

3.03 SURFACE MARKERS

Outside paved areas provide stakes for pipelines 24-inch and larger at 500 feet intervals and at all changes in alignment or end of pipe.

END OF SECTION

SECTION 02233

WATERING

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of furnishing, hauling, and applying water required in the compaction of embankments, backfills, subgrade, and base course, and for landscaping, dust control, leak testing, and other construction operations.

PART 2: MATERIALS

2.01 WATER

A. Recycled water for construction and pipe pressure testing purposes may be available from the Owner. The Contractor will be allowed to draw water only at the locations approved by the Engineer. The Contractor shall be responsible for coordinating with the Engineer for the use of this water.

B. Leakage testing for hydraulic structures shall be conducted with, at a minimum, Tertiary treated effluent.

C. No provision in this section is intended to prevent the Contractor from making arrangements for water from other than Owner sources. All costs involved shall be the responsibility of the Contractor's.

D. Potable water for use by the Contractor for Construction or other purposes shall coordinated by the Contractor at the Contractor's expense.

PART 3: EXECUTION

3.01 EQUIPMENT

Contractor shall provide all necessary pumping equipment, piping, meters, tanks, and water trucks to withdraw and utilize the water. Water trucks shall be of at least 1,000 gallon capacity, equipped with a spray bar of ample capacity and design to insure uniform application of water in the amounts required.

END OF SECTION

SECTION 02270

STORMWATER RUNOFF CONTROL PROGRAM

PART 1: GENERAL

1.01 DESCRIPTION

A. Requirements for the preparation and implementation of the Stormwater Pollution Prevention Plan (SWPPP) for the Contractor's construction activities. This document (and others identified in this Section will be used for the purpose of applying for and obtaining a State of California General Construction Activity Stormwater Permit. This permit authorizes the discharge of stormwater associated with construction activities from the construction site.

B. If the site disturbed is greater than 1.0 acre, the Contractor will be responsible for composing a complete SWPPP that includes all elements set forth in Section A, "Storm Water Pollution Prevention Plan", of the General Permit. The Contractor will also be responsible for composing an M&RP that satisfies the requirements set forth in Section B, "Monitoring Program and Reporting Requirements", of the General Permit.

C. For sites less than 1.0 acre, the contractor shall submit a Water Pollution Control Plan describing the Best Management Practices (BMPs) planned to be used along with their locations marked on the contract drawings.

D. The Contractor will be responsible for obtaining coverage under the General Permit and finalizing the SWPPP and M&RP prior to commencing construction. The SWPPP and M&RP must be approved by the Engineer before they are considered finalized.

E. Disposal of construction water from operations such as groundwater dewatering and water used for testing, disinfecting, and flushing pipelines is not part of the work under this section. Refer to Sections 02140, and 02223 for permit requirements for those discharges.

1.02 REFERENCES

A. National Pollutant Discharge Elimination System (NPDES).

B. State of California, State Water Resources Control Board, Regional Water Quality Control Board (SWRCB).

C. United States Code of Federal Regulation (CFR):

1. 40 - Protection of Environment:

    a. 117 - Determination of reportable quantities for hazardous substance.

    b. 302 - Designation, reportable quantities, and notification.

1.03 RELATED WORK DESCRIBED ELSEWHERE

A. Section 01010: General Construction Information and Requirements

B. Section 01300: Submittals

C. Section 02223: Trenching, Backfilling, and Compacting

1.04 GENERAL CONSTRUCTION ACTIVITY STORMWATER PERMIT

A. The Contractor shall read and be familiar with all requirements contained in the General Permit necessary to implement and maintain a viable SWPPP and M&RP. The Contractor shall comply with all the requirements set forth in the General Permit.

B. The Contractor shall note that compliance with the requirements contained in the General Permit may require the use of pollution control procedures outside the limits of immediate construction activity, (e.g., tarping haul truck to prevent fugitive dust or debris).

1.05 NOTICE OF INTENT

The General Permit requires a Notice of Intent (NOI) to be filed with the SWRCB. A copy of this NOI must be included in the SWPPP. The Contractor shall file the NOI with the SWRCB and provide a copy to the Owner with the completed SWPPP.

1.06 SUBMITTALS

A. Construction General Permit (for sites greater than 1.0 acre):

1. The Contractor shall prepare and submit all Permit Registration Documents (PRDs) to the Engineer for review, approval, and certification by the Legally Responsible Person (LRP) prior to start of work and mobilization:

    a. The LRP will electronically submit the PRDs to the Stormwater Multiple Application and Report Tracking System (SMARTS) to obtain approval of the Construction General Permit (CGP).

2. The PRDs shall include but are not limited to the Notice of Intent (NOI), Risk Determination Worksheet, Site Maps, Stormwater Pollution Prevention Plan (SWPPP), Annual Fee's and Owner Certification. It shall also include all

other reports, calculations, studies, exhibits, and documentation required to obtain the CGP.

3. The Contractor shall provide a Qualified SWPPP Practitioner (QSP), who will be responsible for maintaining the existing CGP active throughout the duration of the project:

    a. The Contractor shall be responsible for providing all reports required by the CGP (monitoring, inspection, Rain Event Action Plans, sampling, exceedance reports, annual reports, etc) to the Engineer for review.

    b. Upon approval, the Contractor's QSP shall upload the information to SMARTS.

    c. Time sensitive reports involving monitoring data shall be provided as soon as the information is made available.

    d. All other reports shall be provided to the Engineer a minimum of 2 weeks prior to their deadline for submittal to the SWRCB through SMARTS.

    e. All CGP documents shall be submitted to the Owner for reference and a copy shall be located on site at all times.

B. Pollution Prevention Plan:

1. Prepare and submit a site-specific Stormwater Pollution Prevention Plan (SWPPP) in accordance with Section A of the General Construction Activity Stormwater Permit to the Owner for reference.

2. Prepare and submit a monitoring program and reporting plan in accordance with Section B of the General Construction Activity Stormwater Permit to the Owner for reference.

3. Submit to the Owner for reference a Stormwater Pollution Prevention Plan detailing the placement of physical Best Management Practices (BMPs) required for installation and the methods used to comply with those BMPs directed at operational procedures, Monitoring Program, and Reporting Plan.

4. The plan shall specifically address and detail changes from the alternatives called out in this Section. The Contractor's preferred techniques shall show how it will comply with the stated objectives of the program.

5. The SWPPP shall be prepared and amended by a Qualified SWPPP Developer (QSD), as defined by the CGP

6. The Stormwater Pollution Prevention Plan shall discuss any non-stormwater sources (i.e., landscaping irrigation, pipe flushing, street washing, and dewatering). In addition, the Plan shall include standard observation measures and best management practices, including best available technologies economically achievable and best conventional pollutant control technologies that are to be implemented in order to reduce the pollutant loading to the waters.

C. Water Pollution Control Plan

1. List and descriptions of all BMPs that are planned to be implemented

2. General location markups of BMPs on the contract drawings

3. Spoils locations, hazardous waste area, stockpiling, etc.

D. The Contractor shall submit a copy of the BMP Handbook with each BMP to be utilized check marked to show compliance or marked to show deviation.

E. The submittal shall detail the Contractor's selected BMPs with brief justification on why that BMP is selected, the intended installation date and location on the site. BMP materials and specifications shall be provided, including, where applicable, reference to BMPs described in Specification Section 02273. If the Contractor believes additional or alternative BMPs are necessary, details shall be provided. The Contractor will be required to revise or supplement submitted information that is inadequate or incomplete in the opinion of the Engineer.

F. Once the information is compiled, the Contractor will finalize and submit the proposed SWPPP to the Owner and Engineer for final acceptance. The SWPPP will be posted on-site during the duration of the project for reference in compliance monitoring.

G. The Contractor shall be responsible for taking the proper actions to prevent contaminants and sediments from entering the storm sewer drainage system should any unforeseen circumstance occur. The Contractor shall take immediate action if directed by the Engineer, or if the Contractor observes contaminants and/or sediments entering the storm drainage system, to prevent further stormwater from entering the system.

H. In the event the Contractor desires to implement environmental protection BMPs differently than detailed in the Plans and Specifications or the SWPPP, the Contractor may provide a submittal with his alterations/amendments to the Engineer. All alterations or amendments must get prior authorization from the Engineer as outlined in the SWPPP. However, if the Contractor desires to implement alternative BMPs to those detailed exclusively in the SWPPP for an

emergency repair to prevent an offsite discharge, he may do so without prior consent. No schedule delays will be allowed due to BMP revisions proposed by the Contractor, unless authorized by the Owner.

1.07 MEASUREMENT AND PAYMENT

The Contractor shall be responsible for all costs associated with the development of the SWPPP and M&RP. The Contractor shall be responsible for the implementation of the SWPPP and M&RP. This includes the installation, maintenance, and removal of erosion and sediment control practices specified in the SWPPP upon completion of the project or as requested by the Engineer. These costs shall be included in the lump sum bid amount.

PART 2: MATERIALS

2.01 STORMWATER POLLUTION PREVENTION PLAN

A. The Contractor shall utilize all materials as approved and as necessary to implement a successful SWPPP in accordance with the requirements specified in the General Permit. Refer to Section 02272 for materials used in vegetative erosion control and specification Section 02273 for material used in additional BMPs.

B. The Contractor is responsible for implementing the Best Management Practices to maintain positive pollution prevention, as described in the SWPPP, in response to the monitoring program reports, or as circumstances require. Materials, and the costs thereof, for stormwater pollution prevention are the responsibility of the Contractor.

PART 3: EXECUTION

3.01 REGULATORY REQUIREMENTS

A. The Contractor shall comply with the State Water Resources Control Board, Regional Water Quality Control Board, county, city, and other local agency requirements regarding stormwater discharges and management.

B. The Contractor shall not begin any construction work until the Owner receives the State of California General Construction Activity Stormwater Permit. The Contractor shall allow the Owner 30 days to obtain this permit after receipt of the information listed in this Section.

C. The Contractor shall comply with the following prohibitions and limitations, which are contained in the Stormwater Permit:

1. Discharge prohibitions:

a. Discharges of materials other than stormwater, which are not otherwise regulated by a NPDES permit, to a separate stormwater sewer system or water of the nation are prohibited.

b. Stormwater discharges shall not cause or threaten to cause pollution, contamination (including sediment), or nuisance.

c. Stormwater discharges regulated by this general permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR 117 and 40 CFR 302.

2. Receiving water limitations:

a. Stormwater discharges to any surface or groundwater shall not adversely impact human health or the environment.

b. Stormwater discharge shall not cause or contribute to a violation of any applicable water quality standards contained in the California Ocean Plan, Inland Surface Waters and Enclosed Bays and Estuaries Plan, or the applicable Regional Water Board's Basin Plan.

D. The Contractor's QSP shall implement all activities required by the General Permit and as detailed in the Stormwater Pollution Prevention Plan, Monitoring Program, and Reporting Plan.

E. The Contractor's QSP shall amend the Stormwater Pollution Prevention Plan, Monitoring Program, and Reporting Plan whenever there is a change in construction or operations which may affect the discharge of pollutants to stormwater.

F. The Stormwater Pollution Prevention Plan shall also be amended if it is in violation of any conditions of the general permit or has not achieved the general objective of reducing pollutants in stormwater discharges.

3.02 GENERAL

A. The SWPPP and M&RP shall be developed by the Contractor and submitted to the Owner. The SWPPP and M&RP must be accepted by the Owner and approved by the Engineer prior to commencement of construction activities in the field.

B. The Contractor will provide, at a minimum, site specific information as listed in 1.05 Submittals:

C. The Contractor shall comply with all conditions identified in the General Permit, which could apply to the work under this contract.

D. The Contractor shall be responsible for the compliance of his personnel and subcontractors with the SWPPP and the implementation of the M&RP.

E. The SWPPP (document) shall be kept on site during construction activity and made available upon request of a representative of the SWRCB and/or other regulatory agency.

F. The Contractor shall employ BMPs as detailed in the SWPPP during construction operations to adequately prevent the discharge of pollutants to surface waters, including the municipal storm sewer system.

3.03 STORMWATER POLLUTION PREVENTION PLAN

The SWPPP shall include all the requirements set forth in Section A, "Storm Water Pollution Prevention Plan", of the General Permit. The SWPPP shall provide a description of potential sources which are likely to add significant quantities of pollutants to stormwater discharges or which may result in non-stormwater discharges from the construction site. The SWPPP, similar to this specification Section and specification Sections 02272 and 02273, also provides guidelines on how to prevent potential pollutants and commingled waters from leaving the site, as well as wind-induced sediment transport.

3.04 MONITORING & REPORTING PROGRAM

A. The Contractor shall implement the M&RP. The Contractor shall also be responsible for monitoring and inspecting his actions and the activities of those responsible to the Contractor.

B. Monitoring and Inspection:

The Contractor will be responsible for completing a Weekly Activity Log, which includes documentation of the following information:

1. Location (using grid map) of weekly construction activities;

2. Confirmation that the appropriate BMPs have been installed per the respective BMP specifications;

3. Confirmation that each BMP is being properly maintained per the respective BMP specifications;

4. Any corrective action taken by the Contractor to ensure proper BMP installation and maintenance;

5. Confirmation that proper housekeeping is being maintained at the site;

6. Confirmation that trash/debris is being controlled and properly stored in covered containers;

7. Confirmation that identified oil spills/leaks are being cleaned up and the contaminated waste and soils are being properly stored and disposed of; and,

8. Evidence that any leaking equipment or vehicles are being taken out of service and repaired prior to continued use.

The Contractor's Weekly Activity Log input will be reviewed for accuracy and completeness by the Engineer or an assigned representative of the Owner. The weekly logs become a part of the Stormwater SWPPP/M&RP as partial evidence of compliance with stormwater management regulations. Any deficiencies identified by the Engineer will be brought to the Contractor's attention and shall be corrected at no additional cost to the Owner.

In addition to the weekly Activity Log, it is the Contractor's responsibility to report to the Owner any discharges immediately after discovery. At the Owner's discretion, the Contractor may be required to notify the appropriate regulatory agency (i.e. Regional Board, DHS). These discharges may include, but are not limited to:

1. Fuels

2. Oils

3. Chemicals

4. Sanitary wastes

5. Process and wash waters

6. Sediment laden waters

C. The Contractor shall allow representatives of the Owner, the Agency, the SWRCB, and/or other regulatory agencies to enter the construction site, inspect the construction site for compliance, and sample and monitor the construction site discharges.

D. The M&RP may extend past the completion date for this contract. The Contractor's responsibilities for the M&RP will cease upon closure of three conditions: 1) acceptance by the Owner of all work under the contract; 2) the Contractor submits information to the Engineer verifying the site meets the criteria for the Notice of Termination (NOT), which the Contractor will submit to the SWRCB for approval; and, 3) final acceptance, not given by Owner until the SWRCB issues approval of the NOT.

3.05 DUTY TO COMPLY

A. The Contractor shall comply with all conditions identified in the General Permit, SWPPP, and M&RP. Nonadherence with the conditions specified in the General

Permit may constitute a violation of the Clean Water Act and the Porter-Cologne Water Quality Control Act and may be grounds for enforcement action by the State, which can carry civil or criminal penalties (some cases under Porter-Cologne exceed CWA penalties of $25,000 per day).

B. The Contractor shall take all reasonable steps to minimize or prevent any discharge in violation of the General Permit.

3.06 COMPLIANCE CERTIFICATION

A. An officer or other authorized representative of the Contractor shall certify the Contractor's stormwater handling roles and responsibilities by signing the "SWPPP Compliance Certification" for the SWPPP (included in Caltrans Storm Water Quality Handbooks, SWPPP/WPCP Preparation Manual), as well as annual reports required under the General Permit. The purpose of these forms is to certify that the construction activity is and has been in compliance or has been modified to comply with the requirements of the General Permit and the SWPPP.

B. During construction, if the Contractor determines that he cannot maintain the site with all of the General Permit and SWPPP requirements, he shall notify the Engineer and Owner immediately. It shall be the responsibility of the Contractor to provide a written Notice of Noncompliance to the RWQCB within 30 days of knowledge of the following noncompliant conditions; which the Contractor may need to provide information for:

1. Failure to certify, by July 1 of each year, that the project's construction activities are in compliance with the provisions of the SWPPP and the Construction General Permit;

2. Failure to implement the BMPs listed within the SWPPP, in accordance with the schedule outlined within the SWPPP;

3. Failure to conduct inspection, monitoring and/or reporting as described within the SWPPP; and/or

4. Failure to initiate corrective actions to BMP breaches, failures and emergency situations.

C. Annual Summary

1. The Contractor shall prepare an annual summary report (annual report) in accordance with all Regional Water Quality Control Board requirements.

2. Utilize the annual report form available in the SMARTS, and submit it to the Engineer a minimum of 2 weeks prior to the deadline for submittal.

3. Upon approval of the report by the Engineer, the LRP will review and certify the report for final submittal via SMARTS.

D. The Contractor shall provide all necessary information for the completion of a Notice of Termination (NOT) upon completion of all construction activities (refer to Section C of the General Construction Activity Stormwater Permit for general requirements). Upon review of the information submitted, the LRP will certify and submit the NOT via SMARTS.

END OF SECTION

Section 02272

VEGETATIVE EROSION CONTROL

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of furnishing and installing vegetative erosion control as specified herein. Vegetative erosion control shall be applied on all disturbed areas that are not paved, graveled, lined or landscaped including all graded or disturbed areas at the treatment plant site and access road. This section describes both the vegetative erosion control efforts with and without anchored straw. The approach without straw shall be utilized between May 1st through October 15th and the process utilizing anchored straw thereafter.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

1.03 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

B. Planting materials shall meet or exceed the specifications of Federal, State, and Local laws requiring inspection for plant disease and insect control.

1.04 SUBMITTALS

A. Comply with pertinent provisions of Section 01300.

B. Submit complete materials list of items proposed to be submitted under this section, complete data on source and quality, and sufficient data to demonstrate compliance with the specified requirements.

PART 2: MATERIALS

2.01 FERTILIZER

A. Commercial fertilizer shall be ammonium phosphate (16-20-0) and contain a minimum of 16 percent nitrogen, 20 percent available phosphoric acid, zero percent water soluble potash, uniform in composition, dry and free flowing, pelleted or granular.

B. All fertilizer shall be delivered in unbroken or unopened containers, labeled in accordance with applicable State regulations and bearing the warranty of the producer for the grade furnished.

2.02 SEED

A. All seed shall be delivered to the site tagged and labeled in accordance with the California Agricultural Code and shall be acceptable to the County Agricultural Commissioner. Seed mixture shall be guaranteed for a minimum of 80% germination.

B. Bag tag figures will be evidence of purity and germination. Time since date of seed test shall not exceed 9 months.

C. Seed shall be of a quality that weed seed shall not exceed 0.5 percent of the aggregate of pure live seed (PLS) (percent germination x percent purity) and other material.

D. Mixture shall include following in proportion to application rates:

(Common Name)	**Pure Live Seed Application Rate – Broadcast (lbs/acre)**
Potamac Orchard Grass	4
Blando brome	10
Lupine	5
California Poppies	2
Intermediate Wheatgrass or Luna Pubescent Wheatgrass	10
Timothy Grass	1

E. Red Fescue Grass shall be used on either side of the oxidation ditch, where irrigation has been provided.

F. Seed shall be furnished separately or in mixture of the proportionate quantities listed above in standard containers with the variety and net weight shown. Based on bag tags, seeding rates shall be adjusted to insure the required amounts of pure live seed.

2.03 INOCULANTS

A. The inoculant for treating legume seeds shall be a pure culture of Nitrogen fixing bacteria prepared specifically for the plant species and shall not be used later than the date indicated on the container. A mixing medium, as recommended by the manufacturer or approved substitute, shall be used to bond the inoculant to the seed.

For non-pellet inoculated seed, two times the amount of the inoculant recommended by the manufacturer shall be used and seed shall be sown within 24 hours.

B. For pellet inoculated seed, at least 30 pounds of inoculant shall be used per 1,000 pounds of raw seed and the seed shall be labeled to show the Lot Number, Expiration Date, and Percent Coat of the finished product. Pellet inoculated seed shall be kept cool and sown within 180 days. Use only fresh, age-dated inoculant specifically labeled for the legume to be seeded.

2.04 WOOD FIBER MULCH

A. Wood fiber shall be a wood cellulose fiber that contains neither germination nor growth inhibiting factors. The wood fiber shall be produced from nonrecycled wood such as wood chips or similar wood materials. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with fertilizer, seed, water, and other approved additives, the fibers in the material will become uniformly suspended to form a homogeneous slurry; and that when hydraulically sprayed on the ground, the material will form a blotter-like ground cover impregnated uniformly with seed; and which after application, will allow the absorption of moisture and allow the rainfall to percolate to the underlying soil. It shall be colored with a nontoxic water-soluble green dye to provide a proper gauge for metering of material over ground surfaces.

B. The wood fiber mulch may also be produced from the following materials:

1. Recycled wood fiber, such as wood chips or similar wood materials;

2. A combination of recycled newsprint and cardboard materials that contain at least 50 percent cardboard; or,

3. A combination of recycled newsprint and non-recycled wood fiber or recycled wood fiber materials that does not contain more than 50 percent newsprint.

C. Cellulose shall be certified to indicate that laboratory and field testing of the product has been accomplished and that it meets all of the foregoing requirements based on testing. Weight specifications of this material from suppliers and for all application shall refer only to air dry weight of the fiber material.

D. Absolute air dry weight is based on the normal standards of the Technical Association of the Pulp and Paper Industry for wood cellulose and is considered equivalent to 10% moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

E. Alternate Mulching Methods: Contractor may either stockpile topsoil (or "duffing") and reapply it 6 inches thick to exposed areas as approved by the Engineer. Or, Contractor may use mechanically punched clean (free of noxious

weed seeds and molds), rice barley, or wheat straw with fibers at less than six inches in length, as approved by the Engineer.

2.05 TACKIFIER

Tackifier/soil binder material shall be one of the following and shall have the property to be evenly dispersed and suspended in water when agitated: M-Binder, Sentinel, Ecotak-SAT, Fish-STIK, Soil Master WR, and Soil Sement.

2.06 WATER

Clean, Potable or Recycled: Add to the slurry mixture in sufficient amount to spread uniformly the required quantity of hydromulch solids.

2.07 STRAW

Straw shall be new straw derived from rice, wheat, oats, or barley that meets the County Agricultural Commissioner's standards for weed pests. Clearance shall be obtained from the County Agricultural Commissioner, as required by law, before straw obtained outside the county in which it is to be used is delivered to the site.

PART 3: EXECUTION

3.10 APPLICATION PROCEDURE

A. General: Erosion control shall consist of surface preparation, seeding, fertilization, mulching, and maintenance, and potentially irrigation. Prior to October 15th, all vegetative erosion control efforts utilizing the hydroseed technique without straw will be the two-stepped process of applying seed, inoculant (if applicable), fertilizer, water, and wood fiber mulch, followed by second step of more mulch, water and tackifier/soil binder. Post October 15 application shall include a middle step of blown straw, which shall then be anchored. After the Engineer has accepted the graded surface, it shall be seeded and mulched. Seeding shall be done preferably between September 15 and October 15, however, hydroseeding can be used as a BMP during the construction season prior to September 15th, if appropriate measures are additionally provided for (i.e. eliminate vehicular traffic on area).

B. Site Preparation: Large rocks (2-1/2" or greater) should be removed from the slopes. Any uneven area should be graded so that water will not collect and cause concentrated flows; refer to Caltrans BMP# SS-4: Hydroseeding in Section 02273, for grading prior to hydroseeding. If the soil surface is crusted from a previous rain, then it should be raked or dragged to break it up. Small clods or a rough appearance should not be of concern as they help to hold the seed and the rainfall. Remove all trash, weeds, and other debris.

Seedbed preparation shall be suspended when soil moisture conditions are not suitable for obtaining a satisfactory seedbed.

C. Fertilization: Fertilizer shall not be applied more than 15 days prior to seeding. Fertilizer shall be distributed uniformly over the seedbed at the rate of 500 pounds per acre.

Fertilizer shall be applied in any way that will result in uniform distribution. It is recommended that fertilizer be applied hydraulically by hydroseeder in the form of a slurry. The slurry shall also contain the required seed, inoculants (if applicable), mulch, and water. Fertilizer shall not remain in the slurry longer than two (2) hours.

D. Seedings:

The seed shall be drilled, broadcast, or distributed uniformly in a water slurry by hydroseeder. The seeds shall be covered by approximately ¼- to ½-inch mulch.

The hydroseeder shall be equipped with a built-in continuous agitation system of sufficient operating capacity to produce a homogeneous slurry and a discharge system that will apply the slurry to the slopes at a continuous and uniform rate.

Seed shall not remain in the slurry longer than thirty (30) minutes. The slurry in this first application shall also contain wood fiber mulch at the rate of 500 pounds per acre and the required fertilizer.

Application rates for wood fiber mulch products that have moisture contents greater than 15 percent shall be increased by the following factor, c:

$$c = \frac{85\ percent}{percent\ \ fiber\ (solids)\ in\ \ product}$$

The wood fiber shall not remain in the slurry longer than two (2) hours. Water used shall be potable water or Class 1 or 2 agricultural irrigation water.

The slurry shall be continuously mixed and shall be mixed for at least five (5) minutes after the last addition before application starts. The slurry shall be applied uniformly over the site at a rate that is nonerosive and minimizes runoff.

E Mulching: areas equal to or greater than 2:1 slope (netting installation regardless of application date) - Material shall be hand punched straw or wood fiber blankets or bio-composite reinforcing matting. Regions with concentrated flow shall have American Excelsior Curlex Enforcer II or equal while regions with high velocity flows shall have American Excelsior Curlex III or equal. Netting rolls shall be applied up and down the slope with a 4-inch minimum side-to-side overlap and a 3-foot minimum end-to-end overlap.

The upper end of the netting shall be buried at least 8 inches into the soil. Overlap of matting shall be provided. Anchor pin or staple spacing shall be 5 feet down sides and center of rolls driven perpendicularly into soil. Spacing at top end and at

end overlaps shall be 1 foot. If manufacturer installation recommendations are more conservative, manufacturer recommendations take precedence.

Areas less than 2:1 slope
(hydromulch seeding installation)

a. General Equipment Requirements: Use hydraulic equipment for the application of the fertilizer, seed, and slurry of prepared wood pulp of the type approved by the Engineer. This equipment shall have a built-in agitation system and operating capacity sufficient to agitate, suspend and homogeneously mix a slurry containing up to 40 pounds of fiber plus combined total of 70 pounds fertilizer solids for each 100 gallons of water. The slurry distribution lines shall be large enough to prevent stoppage and be equipped with a set of hydraulic spray nozzles which will provide a continuous non-fluctuating discharge and delivery of the slurry of the prescribed quantities uniformly, without misses, waste, or erosion. The slurry tank shall have a minimum capacity of 1,000 gallons and be mounted on a traveling unit which may be either self-propelled or drawn with a separate unit which will place the slurry tank and spray nozzles within sufficient proximity to the areas to be seeded so as to provide uniform distribution. The Engineer may allow equipment with smaller tank capacity provided that the equipment has the necessary agitation system and sufficient pump capacity to spray the slurry in a uniform coat.

b. Mulching Prior to October 15th Application:

   Wood fiber with tackifier shall be distributed uniformly over the seeded area in a water slurry by hydroseeder. Application shall be made within 48 hours following seeding.

   The hydroseeder shall be equipped with a built-in continuous agitation system of sufficient operating capacity to produce a homogeneous slurry and a discharge system that will apply the slurry to the slopes at a continuous and uniform rate.

   The slurry in this second step of application shall contain wood fiber at the rate of 1500 pounds per acre and tackifier. The wood fiber shall not remain in the slurry longer than two (2) hours. Water used shall be potable water or Class 1 or 2 agricultural irrigation water.

c. Irrigation: Irrigation of hydroseeded regions shall only be mandated if application is prior to September 15th, and early rains caused germination. Irrigation shall continue until natural atmospheric moisture is enough to sustain growth.

d. Mulching Application After October 15TH:

   A straw covering shall be distributed uniformly over the seeded area within 48 hours after seeding. Straw shall be applied at the rate of two (2) tons per acre. The straw shall be applied by hand, blower, or other

suitable equipment. If straw is applied by blower, it shall not be chopped in lengths less than six (6) inches.

1. Anchoring The Mulch Mechanically: The straw mulch shall be anchored in place via hand tools, mulching rollers, disks, or similar types of suitable equipment alone or in combination with a hydro-mulch material and shall be performed in a satisfactory manner.

2. Anchoring Straw Mulch With Hydro-Process: All post October 15th applications shall utilize a hydro-mulch anchoring process. The hydro-mulch material shall be applied uniformly over the straw in a water slurry by hydroseeder within 48 hours following mulching. The hydromulch shall be wood fiber mulch, a tackifier, and water in the following portions per acre:

TACKIFIER	RATE (pounds)	WOOD FIBER MULCH (pounds)	WATER (gallons)
M-Binder	100	150	700
Ecotak-SAT	100	150	700
Sentinel	100	500	2,000
Fish -STIK	60	500	3,000
Soil Master WR	100	250	1,000

The hydroseeder shall be equipped with a built-in continuous agitation system of sufficient operating capacity to produce a homogeneous slurry and a discharge system that will apply the slurry to the slopes at a continuous and uniform rate.

The materials shall not remain in the slurry longer than two (2) hours. Water used shall be potable water or Class I or 2 agricultural irrigation water.

The slurry shall be continuously mixed and shall be mixed for at least five *(5)* minutes after the last addition before application starts. The slurry shall be applied uniformly over the site at a rate that is nonerosive and minimizes runoff.

F. Preliminary Inspection: Notify the Engineer 48 hours in advance of all seeding. Inspection and favorable review of the completed work shall begin the plant establishment period.

G. Plant Establishment Maintenance:

1. General plant maintenance shall immediately follow seeding and continue until all seeded areas are 85% germinated and covered with acceptable stands of grass and clover.

2. Protect areas against all damage, including erosion and trespass, and provide proper safeguards. Maintain and keep in good repair all temporary barriers erected to prevent trespass. Check all barriers and temporary fencing daily and make immediate repairs or replacements.

3. Repair all damage to seeded areas.

4. Contractor shall irrigate as necessary (refer to 3.01E.c.) to maintain a minimum moisture of 30% percent to a depth in soil of 2-inches to ensure vigorous growth.

5. Continue maintenance for at least 45 days or until the grass is established as approved by Engineer.

H. Initial Inspection for Acceptance: Initial inspection for acceptance will be conducted upon completion of maintenance replacements, and corrective work. Three (3) days notice shall be given. If project improvements, corrective work, and maintenance have not been performed as specified and to the satisfaction of the Engineer, maintenance shall continue at Contractor's expense until such time as work has been successfully completed.

I. Guarantee, Replacement, and Final Acceptance:

1. Guarantee all planting to be in a healthy, thriving condition until the end of the maintenance period.

2. Replace all seeded areas not in vigorous condition as soon as directed by Engineer. Repair any erosion in areas where grass does not become established. Seed mixture used for replacement must be of the same kind and quantity as specified in this section.

3. Final acceptance requires a 4” high stand of plant material, 200 grass plants/ ft^2, and 100% coverage (i.e. no areas larger than 1 ft^2 with less than the specified coverage).

END OF SECTION

SECTION 02273

CONSTRUCTION ACTIVITIES STORMWATER BEST MANAGEMENT PRACTICES

PART 1: GENERAL

1.01 DESCRIPTION

This section describes the types of Construction Activity Best Management Practices (BMP) to be employed by the Contractor at the project site to reduce or eliminate sediment and other pollutants in stormwater and non-stormwater discharges during all phases of construction.

1.02 RELATED WORK DESCRIBED ELSEWHERE

A. Section 02140: Dewatering

B. Section 02270: Stormwater Runoff Control Program

C. Section 02772: Vegetative Erosion Control

D. Caltrans Storm Water Quality Handbooks, Construction Site Best Management Practices Manual, March 2003, or latest edition.

1.03 SUBMITTALS

Prior to any equipment staging and/or earthwork activities, the Contractor shall provide the following:

A. A list of BMP equipment venders and suppliers to be used by the Contractor for this project, including the type(s) of BMP equipment to be provided by each vender/supplier and equipment availability and delivery schedules;

B. A list of qualified personnel/contractors who will be responsible for the following, as described further in this section:

1. Coordinating BMP selection and implementation

2. BMP Installation

3. BMP Inspection and Reporting and Follow-Up

4. BMP Maintenance and Repair

5. BMP removal, if necessary

1.04 PERMITS

A. The Contractor shall be responsible for the development of the site specific erosion prevention plan and sediment control plan as it pertains to the Contractor's project schedule and the location of his equipment and materials. These plans shall be included in the Stormwater Pollution Prevention Plan (SWPPP). The Contractor is required to provide the SWPPP.

B. The Contractor shall be responsible for obtaining any necessary permits from regulating bodies. Obtaining dewatering permits shall be the responsibility of the Contractor.

1.05 MEASUREMENT AND PAYMENT

The Contractor shall be responsible for all costs associated with the procurement, installation, inspection, maintenance and repair, and removal of any construction related stormwater BMP employed at the site.

PART 2: MATERIALS

2.01 FACILITIES AND EQUIPMENT

The Contractor shall provide all necessary facilities and equipment for the selection, installation, inspection, maintenance and repair, and removal of any construction related stormwater BMP employed at the site.

PART 3: EXECUTION

3.01 GENERAL REQUIREMENTS

A. The Contractor, in consultation with the Engineer will select BMPs based on existing and anticipated site conditions.

B. The Contractor will be responsible for providing the necessary equipment and materials to install, inspect and maintain selected BMPs, as described in this section and related Specifications.

C. The Contractor will be responsible for ensuring the selected BMP equipment and materials are available and onsite with sufficient time to be installed prior to their required installation dates per the Contractor-developed BMP Selection and Implementation Schedule.

D. The Contractor shall be responsible for ensuring the installation, inspection, maintenance and repair, and removal of any selected construction related BMP is done by qualified personnel. All temporary BMPs must be removed and immediate surrounds repaired and/or cleaned up at projects completion unless instructed by an Owner's Representative to not do so.

E. The selection, installation, maintenance and repair of any construction related BMP shall, at the minimum, be in accordance with the following control documents:

1. Erosion and Sediment Control Field Manual, Prepared by the San Francisco Bay Water Quality Control Board, and adopted by the Central Valley Regional Water Quality Control Board

2. Caltrans Storm Water Quality Handbook: Construction Site BMPs Manual, March 2003

3. Caltrans Storm Water Quality Handbook: Construction Contractor's Guide and Specifications, April 1997

F. The Contractor shall ensure that water conservation measures are implemented in accordance with Caltrans BMP# NS-1: Water Conservation Practices and Caltrans BMP# NS-7: Potable Water/Irrigation. At no time shall the use of water during construction create or contribute to an unapproved non-stormwater discharge from the site. All non-stormwater discharges must be preapproved by the Engineer and must be documented in the site's Construction Stormwater Pollution Prevention Plan (SWPPP) prior to discharge.

G. The Contractor shall ensure, to the extent practical, that clear water and run-on from offsite sources is directed around the construction site. Where it is not practical to divert run-on and/or concentrated flows around the construction site, the Contractor shall direct run-on and concentrated flows through the construction site in a non-erodible fashion. The diversion of run-on/concentrated flows shall be in accordance with Caltrans BMP# NS-5: Clear Water Diversion, and the following concentrated flow conveyance controls:

1. Caltrans BMP#SS-9: Earth Dikes/Drainage Swales and Lined Ditches

2. Caltrans BMP#SS-10: Outlet Protection/Velocity Dissipation Devices

3. Caltrans BMP#SS-11: Slope Drains

H. The Contractor shall be responsible for obtaining a Dewatering General Permit for any dewatering activity, including removal and discharge of groundwater, accumulated rainwater and removing water from cofferdams or diversions, if necessary. Dewatering activities shall comply with the conditions of the Central Valley Regional Water Control Board's General Permit for Dewatering Activities and shall be in accordance with Caltrans BMP# NS-2 Dewatering Operations.

I. Contractor is responsible to install and maintain BMPs until Notice of Completion by the Engineer. At least seventy percent (70%) of all disturbed areas must be stabilized prior to project acceptance by Engineer.

3.02 EROSION AND SOIL STABILIZATION CONTROLS

A. The Contractor shall prepare a Construction Activity Schedule that addresses the conditions described in Caltrans BMP # SS-01: Scheduling. The Schedule shall be provided to the Engineer upon award of Contract and prior to any construction related activity occurring at the site. The Schedule shall, at the minimum, accomplish the following conditions to the extent practical:

1. Minimize the length of time that soils are left exposed.

    a. The Contractor shall ensure that protective erosion control measures, as described in this section, or equivalent BMPs, be implemented for any disturbed area that will remain exposed for more than 14 days.

    b. All disturbed areas must be stabilized at least 48 hours prior to storm events utilizing the appropriate BMPs described in this section, or an equivalent BMP.

2. Reduce the total area of exposed soils during the raining season (October 1 through May 30). Soil stabilization improvements shall be performed within 14 days after final grade is achieved or all other construction activity on that feature/region is inactive.

3. At all times protect critical areas, including but not limited to drainage channels, creeks, natural water courses and sensitive natural resources (i.e., wetlands).

B. The Contractor shall ensure that existing vegetation is preserved, and preservation measures are inspected and maintained, in accordance with Caltrans BMP # SS-2: Preservation of Existing Vegetation. ALL temporary construction fencing on the WWTRF property shall be removed at contract's end unless otherwise specified by Owner.

C. Soil stabilization BMPs shall be limited to the following, unless the Contractor can recommend alternative BMPs that are deemed as effective by the Engineer:

1. Hydraulic Mulch in accordance with Caltrans BMP# SS-3: Hydraulic Mulch.

2. Hydroseeding in accordance with Caltrans BMP# SS-4: Hydroseeding, however, Section 02272 – Vegetative Erosion Control – holds precedence.

3. Tackifiers/Soil Binders in accordance with Section 02272 – Vegetative Erosion Control. Caltrans BMP# SS-5: Soil Binders, provides supporting information.

4. Straw Mulch in accordance with Section 02272 – Vegetative Erosion Control Control. Caltrans BMP# SS-6: Straw Mulch provides supporting information.

5. Erosion control blankets and mats in accordance with Section 02272 – Vegetative Erosion Control. Caltrans BMP# SS-7: Geotextiles, Plastic Covers and Erosion Control Blankets/Mats provides supporting information.

3.03 SEDIMENT CONTROL BMPS

A. Sediment control BMPs shall only be used in conjunction with erosion control BMPs. The use of sediment control BMPs in the absence of erosion control BMPs is not considered Best Conventional Pollutant Control Technologies (BCT) / Best Available Technologies Economically Achievable (BAT) and will not satisfy the compliance requirements of the Clean Water Act (i.e., the General Permit).

B. Sediment control BMPs shall be limited to the following, unless the Contractor can recommend alternative BMPs that are deemed as effective by Engineer:

1. Silt Fence in accordance with Caltrans BMP# SC-1: Silt Fence.

2. Desilting/Sediment Settling Basin in accordance with Caltrans BMP# SC-2: Desilting Basin.

3. Sediment Trap in accordance with Caltrans BMP# SC-3: Sediment Trap.

4. Check Dams in accordance with Caltrans BMP# SC-4: Check Dams.

5. Fiber Rolls in accordance with Caltrans BMP# SC-5: Fiber Rolls.

C. The use of sandbags and gravel bags are not approved due to the potential to add pollutants to stormwater discharges. Straw bales are discouraged due to the extensive effort to properly install and maintain straw bales as an effective sediment control BMP.

D. The Contractor shall provide for control of offsite discharge of sediments from wind and wind erosion. The use of soil binders or water as a wind erosion BMP shall be in accordance with this specification Section 3.01 (F) and/or Section 3.02 (C) (3).

E. The Contractor shall stabilize construction entrances and exits in accordance with Caltrans BMP# TC-1: Stabilized Construction Entrance/Exit.

F. The Contractor shall stabilize construction roadways in accordance with Caltrans BMP# TC-2: Stabilized Construction Roadway.

3.04 EQUIPMENT RELATED POLLUTANT BMPS

A. Should the Contractor elect to conduct the following activities onsite at any time, the Contractor shall comply with the following BMPs:

1. Equipment and vehicle cleaning shall be done in accordance with Caltrans BMP# NS-8: Vehicle and Equipment Cleaning.

2. Fueling activities shall be done in accordance with Caltrans BMP# NS-9: Vehicle and Equipment Fueling. It is recommended that fuel trucks and equipment be equipped with "Cam-Loc" air tight vapor and liquid recovery systems to minimize fuel spills and releases.

3. At no time shall open containers of equipment fluids be left uncovered and unsecured. Secondary containment shall be provided for all chemical and waste containers. Stacking of open or closed equipment fluid containers on top of other fluid containers on secondary containment pallets is prohibited.

B. Equipment maintenance should be conducted as described below:

1. To prevent or reduce the discharge of pollutants to stormwater from vehicle and equipment maintenance by running a "dry site". This involves using off-site facilities, performing work in designated areas only, providing cover for materials stored outside, checking for leaks and spills, containing and cleaning up spills immediately, and training employees and subcontractors.

   a. Keep vehicles and equipment clean; don't allow excessive build-up of oil and grease.

   b. Use off-site repair shops as much as possible. Maintaining vehicles and equipment outdoors or in areas where vehicle or equipment fluids may spill or leak onto the ground can pollute stormwater. If you maintain a large number of vehicles or pieces of equipment, consider using an off-site repair shop. These businesses are better equipped to handle vehicle fluids and spills properly.

   c. If maintenance must occur on-site, use designated service areas located a minimum of 300 feet away from drainage courses. Surface drainage shall be diverted away/around service and staging areas to prevent the run-on of stormwater and the runoff of spills.

   d. Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.

   e. Place a stockpile of spill cleanup materials where it will be readily accessible.

   f. Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.

   g. Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.

   h. Do not allow leaking vehicles or equipment on-site. If fluid spills or leaking vehicles are detected, take immediate measures to stop the leak and/or properly clean the spill.

i. Repair and maintenance activity shall not take place during wet weather conditions or within 24 hours of a predicted rain event.

j. Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.

k. Train employees and subcontractors in proper maintenance and spill cleanup procedures. All appropriate training sessions should be logged within the SWPPP.

END OF SECTION

SECTION 02400

SHEETING, WALING, AND SHORING

PART 1: GENERAL

1.01 DESCRIPTION

This section covers protective installations consisting of shores, wales, braces, posts, piling, sheeting, anchorages and fastenings required for the work of this project.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02140: Dewatering

B. Section 02221: Utility Trenching and Backfilling

C. Section 02225: Structure Excavation and Backfill

D. Appendix B: Geotechnical Investigation

1.03 QUALITY ASSURANCE

Design Criteria. Contractor shall design and construct temporary sheeting, shoring, and cofferdams, which are to be used as an aid in construction. Design shall be prepared in conformance with applicable requirements of Article 6, "Excavations" of Construction Safety Orders of California State Division of Occupational Health and Safety. In addition, sheet piling design shall be based on the material requirements specified herein. Sloping of excavations shall not be employed below the groundwater or maximum aqueduct water elevation. Designs shall be prepared and signed by a Civil Engineer registered in the State of California and shall be based on the stresses for various materials of construction contained in the latest publication of the International Building Code (IBC). The allowable stresses permitted by the Uniform Building Code may be increased 15 percent for temporary shoring used as an aid to construction.

1.04 SUBMITTALS

A. Submit to the Engineer for record purposes copies of the drawings and calculations used to determine the strength, size, and stability of the protective installations. All designs submitted under this section shall be signed by a Structural or Civil Engineer duly registered in the State of California.

B. Prior to the start of any work involving sheeting and bracing, the Contractor shall obtain a valid excavation permit from the Cal OSHA District office. A copy of the permit and all accompanying drawings, data, and calculations shall be submitted to the Engineer for record purposes only and not for review or approval.

1.05 ALTERNATIVES

The use or application of alternative methods and materials, and the employment of propriety systems under lease or franchise in lieu of that specified herein, may be allowed. Demonstration of suitability and compliance with these specifications and approval of the Owner shall be required.

PART 2: PRODUCTS

2.01 MATERIALS

A. Lumber

Temporary Shores, Wales, and Sheeting. Furnish structural grade planks, beams, and posts as defined and specified for stress-grade lumber in the American Lumber Standards. Lumber may be rough, untreated, in random lengths, and shall be of standard dimensions.

B. Sheet Piling

1. *Material*. Sheet pile shall be manufactured from steel conforming to ASTM A-328, or from steel conforming to ASTM A-572, grade 42.

2. *Dimensions and Section Properties*. Steel sheet piling used for cofferdams or trench sheeting shall be standard rolled sections PZ, PDA, PSA, or PS. The weight, dimensions and section properties shall be appropriate for the intended use, as demonstrated by the design.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General. Install sheeting and bracing for trench and structure excavation as the work requires. Butt planks to and/or interlock sheets to exclude groundwater and fines, preventing the erosion of voids outside sheeting. In soft, wet ground drive sheeting to a lower level as excavation progresses so that sheeting is embedded in undisturbed earth. Bracing of sheet piling may be permitted to penetrate the structural concrete only as approved by the Engineer. Refer to Section 03100. Install wales and struts at close intervals so as to prevent displacement of the surrounding earth and to maintain safe conditions in the work area. Any damage proven to result from improper installation shall be the responsibility of the Contractor.

Temporary sheeting for trench and structure excavation may be removed and re-used. Withdraw individual planks alternatively as the backfill is raised, maintaining sufficient sheeting and bracing to protect the work and workmen. Remove bracing completely. Where unstable conditions occur in the underlying strata from any

cause, and withdrawal of sheeting will endanger the work, a portion of the sheeting, including bracing, may be left in place with approval of the Owner. Remove all wood within a zone extending to four (4) feet below finished grade. Leaving such material in place shall not be cause of an increase in Contract price.

B. Sheet Piling: The Contractor has the option of using steel sheet piling for temporary protective installations. All piping installations shall be continuous.

1. *Installation of Sheet Piling*. Depth of piling shall be sufficient to prevent heave when the trench is dewatered. Piles shall be driven with a hammer with an adequate capacity to complete pile driving without changing hammers. The use of air or water jets to assist in driving the sheet piling will be permitted, providing that the last 5 feet of advance is by driving. Piles shall be driven accurately to the lines and grades shown or required, with each section interlocked with the sheet piles driven previously. To ensure proper alignment of the sheet piles, a driving template or jig shall be used. If any pile is damaged during driving, it shall be removed and replaced. If piles are driven out of interlock or are not properly plumbed or aligned, the piles shall be pulled and re-driven.

2. *Prevention of Damage*. In installing, cutting off, or removing sheet piles, every precaution shall be taken to ensure that damage to the structure or pipeline does not occur. If damage does occur, the Contractor shall perform the necessary repairs at his own expense.

3.02 PROTECTION OF EXISTING FACILITIES

It is the Contractor's responsibility to protect existing facilities from the consequences of his work. Where any sloped excavation infringes on or potentially endangers any existing facilities or structures, provide shoring, sheeting, and bracing according to shop drawings and calculations signed and stamped by a structural or civil engineer registered in the State of California.

END OF SECTION

SECTION 02445

ORNAMENTAL FENCE

PART 1: GENERAL

1.01 DESCRIPTION

A. The work in this section shall include furnishing all labor, materials, equipment, and appliances necessary to complete all ornamental rackable welded steel fence systems.

1.02 RELATED SECTIONS

A. Section 01300: Submittals

B. Section 02450: Ornamental Cantilever Rolling Gates

C. Section 03100: Concrete

1.03 REFERENCES

A.	ASTM A123	Hot Dip Electroplating
B.	ASTM A500	Seamless Grade A Metal Tubing
C.	ASTM B117-97	Salt Spray Corrosion Test
D.	ASTM F593-02e2	Stainless Steel Fasteners
E.	ASTM F1908	Residential Outdoor Swimming Pools
F.	ASTM F2049	Standard Safety Performance for Fence
G.	ASTM F2408	Standard Specification for Ornamental Fences

1.04 SUBMITTALS

A. Product Data:

1. Provide manufacturer’s catalog cuts with printed specifications and installation instructions.

B. Shop Drawings:

1. Supply shop drawings showing the gate system, including details of all major components.
2. Include complete details of fence construction, fence height, and post spacing dimensions.

1.05 WARRANTY

A. The fence system shall be warranted against manufacturing defects by the manufacturer for a period of (20) twenty years from date of sale.

PART 2: MATERIALS

2.01 MANUFACTURER

A. Pisor Fence Division, or equal.

2.02 MATERIALS

A. Rails are Grade A cold rolled steel formed U-Channel having a 50,000 psi yield strength. Pickets are Grade A cold rolled steel formed and welded tubing having a yield strength of 45,000 psi. Both conforming to ASTM A500 with G 60 zinc coating (0.60 oz/ft2) total inside and outside surfaces in accordance with the ASTM A123 hot dipped electroplating process.

B. Height shall be 6 feet unless otherwise shown on the drawings.

2.03 COMPONENTS

A. Rails: 1 ¾" square, 14 ga. formed U-Channel ASTM 500 galvanized steel.

B. Pickets: 1" square, 14 ga., 16 ga., 18 ga. ASTM A500 galvanized welded and formed steel tubing.

C. Posts: 2 ½" square 16 ga., 14 ga., 12 ga., or 3" square 14 ga., 12ga. ASTM A500 galvanized formed and welded steel tubing with powder coated factory finish.

D. Fasteners: All nuts, bolts, and sheet metal screws are stainless steel conforming to ASTM F593-02e2 standard.

E. Color: Black

2.04 STYLE

A. Flat Top (FT), Extended Picket (EXT), Pressed Spear (SP), and Curved Top (CT).

B. 3 15/16" air space between pickets.

C. Fence style shall match the gates specified in Section 02450.

2.05 FABRICATION

A. All panels shall comply with requirements indicated for materials, thickness, design, height, and details of construction.

B. Grommets are inserted into pre-punched rails, and then the pickets are inserted through the grommets.

C. Pickets are attached to the rail via a patented slide lock system.

D. All components are accurately cut and drilled to receive hardware, fasteners and accessories.

E. Panels shall be capable of supporting a 680 lb. load (applied at mid-span) without permanent deformation. Panels shall be rackable to a 24" change in grade.

2.05 FINISH

A. Gate to be mill finish aluminum or color coated with polyester powder as specified. If powder coated, the gate (including track member) and all accessories shall be pretreated chemically by sand blasting or other acceptable method to ensure proper coating adherence.

B. Metal parts are assembled and finished individually prior to shipment.

C. Galvanized steel fence components are cleaned with a non-petroleum solvent followed by the application of a sealing zinc phosphate coating.

D. Immediately after sealing, a two-step finishing process consisting first of an electrostatic dipping process in a lead-free high corrosion resistant epoxy resin leaving a coating of approximately 20 microns followed by a thermosetting carboxyl polyester resin topcoat with a minimum dry film thickness of 60 to 70 microns. The second coating will be applied by the electrostatic spray process.

PART 3: EXECUTION

3.01 PREPARATION

Stake layout showing locations of all gates and posts. Contact "CALL BEFORE YOU DIG" prior to beginning any excavation work.

3.02 INSTALLATION

A. Install fences in accordance with written instructions and in accordance with authorities having jurisdiction.

B. Concrete Set Posts: Drill hole in firm soil. Posts holes will be a minimum of 36" deep (environmental conditions or local codes may require a greater depth). Fence post shall be spaced 95" ± 1/4" on-center to accommodate installation of brackets on 2 ½" square post. For non-level installations the on-center post spacing must be measured along the grade

C. Installation is to conform to the specifications referenced in Section 1.02 of this specification.

D. Install Fortress brackets onto fence section and posts as indicated in printed instructions for specific fence style. Attach fence sections to brackets with approved fasteners and techniques to ensure that fence sections are parallel to grade within ¼" in 12 feet.

E. Gate Installation: Install in accordance with printed instructions. Do not mount gate from wall of a structure. Provide gate post on both sides of a gate. For double drive gate installation, provide concrete center drop to foundation depth and drop rod retainers at center. Lubricate to ensure smooth operation and verify proper latch operation.

3.02 CLEANING

A. Remove all cutting and drilling chips that are attached to the fencing, post, brackets or additions to prevent corrosion.

B. Repair scratches and other installation-incurred damage. Using a spray paint of the appropriate color that includes a zinc additive, repaint and seal any scratches or holes drilled in the fencing, post, brackets, or additions to prevent rust from forming.

C. Clean up debris and unused material and remove from site.

END OF SECTION

SECTION 02450

ORNAMENTAL CANTILEVER SLIDE GATES

PART 1: GENERAL

1.01 DESCRIPTION

A. The work in this section shall include furnishing all labor, materials, equipment, and appliances necessary to complete all Cantilever Slide Gates required for this project in strict accordance with this specification section and drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 02445: Ornamental Fence

1.03 REFERENCES

A. Underwriters Laboratory Gate Operator Requirements (UL 325). See 3.02 C.

1. Automated / operated vehicular gates are not to be used for pedestrian traffic. Separate pedestrian gates must always be provided if pedestrian traffic is expected.

B. ASTM F 2200 – Standard Specification for Automated Vehicular Gate Construction. See 2.01 C.

C. ASTM F 1184 – Standard Specification for Industrial and Commercial Horizontal Slide Gates, Type II, Class 2. See 3.02 B.

D. American Welding Society AWS D1.2 Structural Welding Code. See 2.01 D and 2.03 D.

1.04 SUBMITTALS

A. Product Data:

1. Provide manufacturer's catalog cuts with printed specifications and installation instructions.

2. If operated gate system, furnish two (2) copies of operation and maintenance data covering the installed products.

B. Shop Drawings:

1. Supply shop drawings showing the gate system, including details of all major components.

2. Include complete details of gate construction, gate height, and post spacing dimensions.

C. Certification of Performance Criteria:

1. Manufacturer of gate system shall provide certification stating the gate system includes the following material components that provide superior performance and longevity. Alternate designs built to minimum standards that do not include these additional structural features shall not be accepted.

    a. Gate track system shall be keyed to interlock into gate frame member (providing 200% additional strength when compared to weld only keyless systems). When interlocked with and welded to the "keyed" frame top member, gate track forms a composite structure.

    b. Gate shall have a minimum counterbalance length of 50% opening width which provides a 36% increase in lateral resistance (when compared to ASTM minimum of 40% counterbalance). If gate is ever to be automated, counterbalance section shall be filled with fabric or other specified material.

    c. To provide superior structural integrity, major vertical members shall be spaced at intervals less than the gate frame height and each vertical member, including pickets, shall be welded in place.

    d. Entire gate frame (including counterbalance section) shall include 2 adjustable stainless or galvanized steel cables (minimum 3/16”) per bay to allow complete gate frame adjustment (maintaining strongest structural square and level orientation).

    e. Gate truck assemblies shall be tested for continuous duty and shall have precision ground and hardened components. Bearings shall be pre-lubricated and contain shock resistant outer races and captured seals.

    f. Gate truck assemblies shall be supported by a minimum 5/8” plated steel bolt with self aligning capability, rated to support a 2,000 # reaction load.

    g. Hanger brackets shall be hot dipped galvanized steel with a minimum 3/8” thickness that is also gusseted for additional strength.

    h. Gate top track and supporting hangar bracket assemblies shall be certified by a licensed professional engineer to withstand a 2,000 lb. vertical reaction load without exceeding allowable stresses

D. Certifications:

1. Gate in compliance with ASTM F 2200, Standard Specification for Automated Vehicular Gate Construction per section 2.01 C.
2. Gate operator shall be provided and shall be in compliance with UL 325 as evidenced by UL listing label attached to gate operator.
3. The aluminum welders and welding process must be certified per section 2.03 D.
4. Manufacturer shall supply gate design performance certification as per section 1.03 C.

PART 2: MATERIALS

2.01 CANTILEVER SLIDE GATE MANUFACTURERS

A. Manufacturer shall be Pisor Fence Division, or equal.

B. Approved substitution – All other systems must be submitted to the design team in accordance with substitution requirements as set forth in the general provisions of the specification manual for approval prior to the bid date. Products submitted after the bid date will not be approved.

C. Gate manufacturer shall certify gate is manufactured in compliance with ASTM F 2200, Standard Specification for Automated Vehicular Gate Construction. See 1.03 D.1.

D. Gate manufacturer shall provide independent certification as to the use of a documented Welding Procedure Specification and Procedure Qualification Record to insure conformance to the AWS D1.2 welding code. Upon request, Individual Certificates of Welder Qualification documenting successful completion of the requirements of the AWS D1.2 code shall also be provided. See 1.03 C.2.

2.02 GATE DIMENSIONS

A. Gate dimensions shall be as shown on the detail drawings.

2.03 GATE CONSTRUCTION DETAILS

A. Gate Frame:

1. The gate frame shall be fabricated from 6063-T6 aluminum alloy extrusions. The top member shall be a 3" x 5" (76mm x 127mm) aluminum structural channel/tube extrusion weighing not less than 3.0 lb/lf (4.4kg/m) for Internal Picket designs or 2.6 lb/lf (3.8kg/m) for External Picket designs. To maintain structural integrity this frame member shall be "keyed" to interlock with the “keyed” track member. If fabricated as a single horizontal piece, the bottom member shall be a 2" x 5" (51mm x 127mm) aluminum structural tube weighing not less than 2.0 lb/lf (2.9kg/m). If fabricated in two horizontal pieces, the bottom member shall be a 5" (127mm) aluminum structural channel weighing not less than 2.6 lb/lf (3.8kg/m). When the gate frame is manufactured in two horizontal pieces or sections, they shall be spliced in the field (the gate frame shall be fabricated in one or multiple sections depending on size requirements or project constraints).

B. Vertical Members (Ornamental Picket):

1. Ornamental Picket (Internal and External): The vertical members at the ends of the opening portion of the frame shall be 2” x 2” (51mm x 51mm) in the cross section weighing not less than 1.1 lb/lf (1.6kg/m). The major vertical members separating each bay shall be 1” x 2” (25mm x 51mm) in cross section weighing not less than .82 lb/lf (1.2kg/m).

C. Gate Track:

1. The gate frame shall have a separate semi-enclosed “keyed” track, extruded from 6005A-T61 or 6105-T5 aluminum alloy, weighing not less than 2.9 lb/lf (4.2kg/m). The track member is to be located on only one side of the top primary. When interlocked with and welded to the "keyed" top member, it forms a composite structure with the top of the gate frame. Welds to be placed alternately along the top and side of the track at 9" (229mm) centers with welds being a minimum of 2" (51mm).

D. All welds on the gate frame shall conform to Welding Procedure Specification and Procedure Qualification Record to insure conformance to the AWS D1.2 Structural Welding Code. All individual welders shall be certified to AWS D1.2 welding code. See 1.03 D.3.

E. Gate Mounting:

1. The gate frame is to be supported from the track by two (2) swivel type, self-aligning, 4 wheeled, sealed lubricant, ball-bearing truck assemblies.

2. The bottom of each support post shall have a bracket equipped with a pair of 3” (76mm) UHMW guide wheels Wheel cover protectors shall be included with bottom guides to comply with UL325.

3. Gap protectors shall be provided and installed, compliant with ASTM F 2200-05.

F. Diagonal "X" bracing of 3/16" or 1/4” diameter stainless or galvanized steel cable shall be installed throughout the entire gate frame.

G. The gate shall be completed by installation of approved filler as specified.

1. Ornamental Picket: Picket sizes shall be 1” (25mm) square. Pickets may extend through only the clear opening portion or through the entire length of the gate as required. If a motorized gate operator is to be applied to the gate and the specified picket spacing allows for openings in the gate frame that exceed 2¼” (57mm), a secondary gate filler shall be secured at each end of the gate frame and tied at each 1” x 2” (25mm x 51mm) or 2” x 2” (51mm x 51mm) vertical member. The secondary gate filler shall extend to a minimum height of 72” (1.2m) above grade and shall be sized to prevent a 2¼” (57mm) diameter sphere from passing through openings anywhere along the length of the gate frame, and in that portion of the adjacent fence that the gate covers in the open position.

2.04 POSTS

A. A single set of support posts shall be minimum 4" O.D. (102mm) round SS40 or 4” x 4” x 3/16” wall square steel tubing, grade 500. Gate posts shall be galvanized or coated and supported in concrete footings as specified by the Engineer.

2.05 FINISH

A. Gate to be mill finish aluminum or color coated with polyester powder as specified. If powder coated, the gate (including track member) and all accessories shall be

pretreated chemically by sand blasting or other acceptable method to ensure proper coating adherence.

B. Color: Black

2.06 GATE OPERATORS

Gate operators shall be 120V, ½ HP, UPS battery backup, with keypad and KNOX key access. SCADA open/close control and status I/O. Provide all local wiring and conduits.

Manufacturer: HySecurity SlideSmart CNX or Equal.

2.07 WARRANTY

A. The track assembly shall be warranted against manufacturing defects by the manufacturer for a period of (5) five years from date of sale.

PART 3: EXECUTION

3.01 FINAL GRADES

Final grades and installation conditions shall be examined. Installation shall not begin until all unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Equipment in this section shall be installed in strict accordance with the company's printed instructions unless otherwise shown on the contract drawings.

B. The gate and installation shall conform to ASTM F 1184 standards for aluminum cantilever slide gates, Type II, Class 2. See 1.02 C.

C. If the gate system is to be automated, the gate and installation shall also comply with ASTM F 2200 and UL 325. See 1.02 A and 102 B.

3.02 SYSTEM VALIDATION

A. The complete system shall be adjusted to assure it is performing properly.

B. The system shall be operated for a sufficient period of time to determine that the system is in proper working order.

C. For operated gate systems - test and explain safety features:

1. Each system feature and device is a separate component of the gate system.
2. Read and follow all instructions for each component.
3. Ensure that all instructions for mechanical components, safety devices and the gate operator are available for everyone who will be using the gate system.
4. The warning signs shipped with the gate operator must be installed in prominent position on both sides of the gate.

5. Ensure the owner is clear with regard to the safety points concerning the basic operational guidelines of the safety features of the gate operator system. These safety points are listed in the gate operator manual and must be read prior to system use.

END OF SECTION

SECTION 02513

ASPHALT CONCRETE PAVING

PART 1: GENERAL

1.01 DESCRIPTION

This section includes materials, testing, and installation of asphalt concrete pavement, aggregate base course, herbicide, prime coat, tack coat, and seal coat.

1.02 RELATED WORK SPECIFIED ELSEWHERE

Section 02200: Earthwork

1.03 SUBMITTALS

Submit six copies of a report from a testing laboratory verifying that aggregate material conforms to the specified gradations or characteristics.

PART 2: MATERIALS

2.01 ASPHALT CONCRETE PAVING

Asphalt concrete paving shall conform to Type B in Section 39 of the State Specifications, having ½-inch-maximum medium grading.

2.02 AGGREGATE BASE COURSE

Aggregate base shall be Class 2 aggregate base, ¾-inch-maximum size per Section 26 of the State Specifications. Aggregate shall contain no detectable asbestos.

2.03 PRIME COAT

All areas to be paved shall receive prime coat. Prime coat shall be per Section 37-2.02 and Section 93 in the State Specifications.

2.04 TACK COAT

Tack coat shall conform with SS1 paving asphalt per Section 94 in the State Specifications.

2.05 ASPHALT

Asphalt shall be PG 64-10. Asphalt content in the pavement shall be 5.5% to 6.0%.

2.06 AGGREGATE FOR ASPHALT CONCRETE

Aggregate shall be Type B per Section 39-1.02 E in the State Specifications. Aggregate

shall contain no detectable asbestos.

2.07 SEAL COAT

Seal coat shall be Type II slurry seal per Section 37 of the State Specifications.

2.08 HEADER

Header shall be 6" x 3" Permaloc AsphaltEdge with black duraflex finish installed per manufacturer recommendations.

2.09 HERBICIDE OR WEED KILLER

Use oxy-monobar chlorate, Occidental; Pramitol 3OWP, CIBA-Geigy; or equal.

2.10 PAINT FOR TRAFFIC AND PARKING LOT STRIPING AND MARKING

Provide white thermoplastic paint per Section 84 of the State Specifications.

PART 3: EXECUTION

3.01 PAVEMENT REMOVAL

A. Initially cut asphalt concrete pavement with pneumatic pavement cutter or other equipment at the limits of the excavation and remove the pavement. After backfilling the excavation, saw cut asphalt concrete pavement to the full depth of pavement at a point not less than 9 inches outside the limits of the excavation or the previous pavement cut, whichever is greater, and remove the additional pavement.

B. Saw cut concrete pavement, including cross gutters, curbs and gutters, sidewalks, and driveways, to the full depth of pavement at a point 1 foot beyond the edge of the excavation and remove the pavement. The concrete pavement may initially be cut at the limits of the excavation by other methods prior to removal and the saw cut made after backfilling the excavation. If the saw cut falls within 3 feet of a concrete joint or pavement edge, remove the concrete to the joint or edge.

C. Make arrangements for and dispose of the removed pavement.

D. Final pavement saw cuts shall be straight along both sides of trenches, parallel to the pipeline alignment, and provide clean, solid, vertical faces free from loose material. Saw cut and remove damaged or disturbed adjoining pavement. Saw cuts shall be parallel to the pipeline alignment or the roadway centerline or perpendicular to same.

3.02 PAVEMENT SECTION

The pavement section for replacement and new shall be as described in the Geotechnical Report

for Light to Medium Auto and Trucks, Traffic Index 5. Three (3) inches AC, 11 inches AB.

3.03 ASPHALT COLD MILLING

Asphalt cold milling shall be performed where called for on plans. Cold milling shall be done using an automated pavement planer capable of maintaining an accurate depth.

A. Cold asphalt milling shall be provided to create an even surface for asphalt overlay. The overall length of the milling machine (excluding the conveyor) shall be a minimum of 18 feet and having a minimum cutting width of six feet. The milling operation shall be operated to effectively minimize the amount of dust being emitted from the machine. Pre-wetting of the pavement may be required in areas where milling is to be performed around utility structures such as manholes, valve boxes etc., proper caution shall be taken as not to damage any of the structures. Saw-cutting of the concrete surrounding the structure and using a pick or other means so as not to disturb the structure shall be employed to prevent any damage. Prior to opening an area which has been milled to traffic, the pavement shall be thoroughly swept with a power broom or other approved equipment to remove to the greatest extent practicable, the fine material which will dust under traffic. This operation shall be conducted in a manner so as to minimize air pollution.

B. The milling operation shall be continuous to avoid delays.

3.04 INSTALLATION

Producing, hauling, placing, compacting, and finishing of asphalt concrete shall conform to Section 39 of the State Specifications. Apply seal coat to all paving except open asphalt concrete.

3.05 CONNECTIONS WITH EXISTING PAVEMENT

Where new paving joins existing paving, saw cut the existing surfaces 12 inches back from the joint line full depth. Dispose of waste material offsite. Tack prior to placing the asphalt concrete. Meet lines shall be straight and the edges vertical. Paint the edges of meet line cuts with liquid asphalt or emulsified asphalt prior to placing asphalt concrete. After placing the asphalt concrete, seal the meet line by painting with a liquid asphalt or emulsified asphalt and then immediately cover with clean, dry sand.

3.06 PREPARATION OF SUBGRADE

A. Scarify subgrade to a depth of 12-inches below finished subgrade elevation and compact to 95% minimum relative compaction. Shape subgrade to line, grade, and cross section shown in the drawings. The subgrade shall be considered to extend over the full width of the base course.

B. The finished subgrade shall be within a tolerance of 0.05 of a foot of the grade and cross section shown and shall be smooth and free from irregularities and at the

specified relative compaction.

3.07 PLACING AGGREGATE BASE COURSE

Place aggregate base course to a minimum thickness as specified for the roadway. Compact to 95% relative compaction. Install in accordance with Section 26 of the State Specifications.

3.08 COMPACTION OF AGGREGATE BASE AND LEVELING COURSES

Compaction and rolling shall begin at the outer edges of the surfacing and continue toward the center. Apply water uniformly throughout the material to provide moisture for obtaining the specified compaction. Compact each layer to the specified relative compaction before placing the next layer.

3.09 PLACING TACK COAT

Apply tack coat on surfaces to receive finish pavement per Section 39-1.09C in the State Specifications. Apply tack coat to metal or concrete surfaces that will be in contact with the asphalt concrete paving.

3.10 PLACING ASPHALT PAVING

Install in accordance with Section 39-2 in the State Specifications.

3.11 COMPACTION OF ASPHALT CONCRETE PAVING

Compact until roller marks are eliminated and a density of 92% minimum to 98% maximum has been attained per ASTM D 2041. Compacting equipment shall conform to the provisions of Section 39-2.04, “Compacting Equipment.”

3.12 APPLYING SEAL COAT

Apply slurry seal coat at the rate of 10 to 18 pounds of dry aggregate per square yard.

3.13 SURFACE TOLERANCE

A. Finished grade shall not deviate more than 0.02 foot in elevation from the grade indicated in the drawings. Slopes shall not vary more than 1/4 inch in 10 feet from the slopes shown in the drawings.

B. After paving has been installed and compacted, spray water over the entire paved area. Correct any areas where water collects and does not drain away.

END OF SECTION

SECTION 02601

MANHOLES AND CLEANOUTS

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of the furnishing of materials and constructing there with new manholes and cleanouts as shown on the drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 01666: Testing of Gravity Sewer Lines and Manholes

C. Section 02223: Trenching Backfilling and Compacting

D. Section 02225: Structure Excavation and Backfill

E. Section 03100: Concrete

1.03 QUALITY ASSURANCE

Standards, American Association of State Highway and Transportation Officials (AASHTO) and American Society for Testing and Materials (ASTM).

1.04 SUBMITTALS

A. Shop Drawings, stamped calculations, and catalog cut sheets shall be submitted for manhole, frames and covers, precast manhole bases and sections, joint sealer, cleanout meter box, pressure clean-out covers, and epoxy lining in accordance with Section 01300.

1. Calculations shall be stamped by a State of California registered Professional Engineer.

B. All manholes and manhole bases are to be precast concrete; cast-in-place manhole bases are not permitted except for unusual circumstances that must be approved by the engineer. Additional requirements will apply if cast-in-place manholes are permitted by the engineer.

PART 2: MATERIALS

2.01 FRAMES AND COVERS

A. All castings for manhole frames and covers shall be of tough, uniform quality, gray

iron, free from cracks, holes, swells, cold shuts or other defects and be of workmanlike finish. Castings for frames and covers shall conform to the requirements of the "Specifications for Gray Iron Castings," Class 25 (ASTM A48).

B. Horizontal surfaces of manhole cover seats and under surface of the seat cover which rests upon the frame shall be machined. After machining, it shall not be possible to rock any cover after it has been seated in any position in its frame. Manhole frames and covers shall be designed for heavy duty, H-20 traffic loading. All manholes shall be provided with a nominal 24-inch diameter cover unless otherwise noted on the drawings. Manhole frames shall be capable of receiving standard non-shifting manhole extension (riser) rings.

C. Manhole frames and covers shall be South Bay Foundry SBF-1900, D&L Foundry A-1024-R4 or Phoenix Iron Works Model P1090 R/G. All covers are to have blind, closed pickholes. The wording in the covers shall include the word "sewer" in the lid.

2.02 PRECAST CONCRETE MANHOLE SECTIONS

Manholes shall be constructed of precast reinforced manhole sections conforming to ASTM C478 and as shown. Precast concrete rings, cones, and flat slabs shall be manufactured by a process that will produce a dense, homogeneous concrete section of first quality. Cement used in all precast sections shall conform to State Specifications "Type II Modified".

2.03 PRECAST MANHOLE BASES

Precast manhole bases as manufactured by Jensen Precast, Forterra Concrete Products, Oldcastle Precast or equal, may be used, subject to approval.

A. Precast manhole bases shall be set atop compacted drain rock graded level.

2.04 PRECAST CONCRETE MANHOLE FLAT LID

A. Designed to meet H-20 loading requirements.

B. Tested in accordance with ASTM C497.

2.05 CONES

All manhole cones shall be eccentric unless otherwise shown on the plans and conform to ASTM designation C478.

2.06 JOINT SEALER

The joint sealer shall be Ram-Nek by K.T. Snyder Company, Inc.; Kent-Seal by Hamilton-Kent, or equal.

2.07 CLEANOUTS

Cleanout covers shall be concrete meter box with cover, Brooks No. 36; Christy B9 Utility Box, with B9D lid, or equal.

2.08 MORTAR

One part Portland cement, 1 part hydrated lime, and 6 parts sand.

2.09 NON-SHRINK GROUT

Shall be non-shrink epoxy type suitable for pressure grouting, Embeco; Master Builders Co., or equal.

2.10 INTERIOR AND EXTERIOR COATINGS

A. Exterior: Buried exterior concrete shall be coated with an emulsified asphalt coating, Specification Section 07175.

B. Interior: Refer to Specifications Section 09900.

PART 3: EXECUTION

3.01 SETTING BASES

A. Construct to grades, lines and elevations shown on the drawings or staked in the field. Shape tops of the bases by means of accurate bell-ring forms to receive the barrel section. Wet setting is not permitted. Joint sealer shall be placed on the first joint after the Engineer has approved the manhole base for stacking. The concrete shall cure a minimum of 24 hours before stacking the barrel sections.

Pour foundations on 12-inches of compacted crushed rock wrapped in filter fabric. See section 02200 and standard manhole details.

B. Precast bases shall be placed on 12-inches of compacted crushed rock wrapped in filter fabric. See section 02200 and standard manhole details.

C. Pipe Stubs shall be built into the structures as shown on the plans. The outer ends shall be sealed securely by a removable stopper of the same material as the branch.

3.02 SETTING PRECAST SECTIONS

Precast-reinforced concrete sections shall be set so as to be vertical and with sections in true alignment. Joints shall be primed and made with sealer applied in strict accordance with the manufacturers printed instructions.

A. Grade rings shall not exceed a total height of 12 inches unless approved by the

Engineer prior to installation. Grade rings shall be set plumb using the specified filler at all joints.

3.03 FIELD CONNECTIONS

Openings for field connections shall be made with a motor driven cutting tool which will provide a smooth round opening no more than 3 inches larger than the outside diameter of the pipe being connected. Jack hammers and chipping hammers will not be allowed. Gravity sewer connections shall be made with NPC Kor-N-Seal, A-lok G3, or Press-Seal PSX Direct Drive Nitrile. Submerged, periodically submerged, or connections in are to be made with Link Seal Model S-316 or CCI Wrap-It-Link, Type WL-SS.

3.04 INTERIOR DROPS

Install interior drops as detailed on the plans.

3.05 INVERT CHANNELS

Smooth and semi-circular in shape conforming to the inside of the adjacent sections. Make changes in flow direction by a smooth curve of radius as large as permitted by manhole size. Make changes in size and grade gradually and evenly. See plans for details.

3.06 SETTING FRAMES AND COVERS

Frames and covers shall be set as detailed on the plans for various locations.

3.07 CLEANOUTS

Installation of cleanouts shall be as detailed on the drawings.

3.08 MANHOLE TESTING

A. Perform testing in the Engineer's presence prior to backfilling and interior coating. Notify Engineer at least 48 hours prior to testing.

B. Sewer manholes shall be tested in accordance with the requirements of Section 01666.

END OF SECTION

SECTION 02621

FILTER FABRIC

PART 1: GENERAL

1.01 DESCRIPTION

This section includes materials and installation of nonwoven geotextile fabric riprap over properly prepared subgrade the protection of channels, structures, and embankments. Refer to the Geotechnical Report in Appendix B of the Contract Documents for additional requirements.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02210: Site Grading

B. Section 02221: Utility Trenching and Backfill

C. Section 02225: Structure Excavation and Backfill

1.03 REFERENCES

A. ASTM International (ASTM):

1. D 4491 - Standard Test Method for Water Permeability of Geotextiles by Permittivity.

2. D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

3. D 5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

1.04 DEFINITIONS

A. Filter fabric: Nonwoven geotextile fabric manufactured from polypropylene fibers.

1.05 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:

1. Certificates of Compliance.

2. Manufacturer's Instructions.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:

1. Furnish filter fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.07 PROJECT CONDITIONS

A. Take field measurements to determine the lengths and dimensions of the surfaces to receive the fabric.

PART 2: PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:

1. Amoco, Style 4550.

2. TenCate Nicolon, Charlotte, NC, Mirafi 140N.

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements:

PROPERTY	TEST METHOD	REQUIREMENT (1)
Minimum Weight	ASTM D 5261	4.5 ounces per square yard
Grab tensile strength	ASTM D 4632	100 pounds
Grab tensile elongation	ASTM D 4632	50 percent.
Minimum Permittivity	ASTM D 4491	1.7 per second

(1). Minimum average roll values.

PART 3: EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of filter fabric.

3.02 PREPARATION

A. Surface preparation:

1. During grading operations, take care not to disturb the subgrade.

2. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented herein.

B. Place the filter fabric smoothly without folds or wrinkles.

C. Use special care when placing the filter in contact with the soil so that no void spaces occur between the filter and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than manufacturer's instructions.

E. Do not drag filter fabric across subgrade.

3.04 FIELD QUALITY CONTROL

A. Inspection:

1. Before covering, the condition of the fabric will be observed by the Engineer to determine that no holes or rips exist in the fabric.

2. Repair all holes and rips by placing a new layer of fabric extending beyond the defect in all directions a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

SECTION 03071

EPOXIES

PART 1 GENERAL

1.1 SUMMARY

Section Includes:

A. Epoxy.

B. Epoxy gel.

C. Epoxy bonding agent.

1.2 REFERENCES

American Society for Testing and Materials (ASTM):

A. D638 - Standard Test Method for Tensile Properties of Plastics.

B. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

C. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.3 SYSTEM DESCRIPTION

Performance Requirements:

A. Provide epoxy materials that are new and use them within shelf life limitations set forth by manufacturer.

B. Perform and conduct work of this Section in neat orderly manner.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data completely describing epoxy materials.

B. Quality Control Submittals:

1. Manufacturer's installation instructions.

PART 2 MATERIALS

2.1 MATERIALS

A. Epoxy: Water-insensitive 2-part type low viscosity epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified: Manufacturers: One of the following or equal:

1. Master Builders, Inc., Concressive Standard LVI.

2. Sika Chemical Corp., Sikadur 35 Hi-Mod LV.

Physical Characteristic	Test Method	Required Results
Tensile Strength	ASTM D638	8,000 pounds per square inch minimum at 14 days and 77 degrees Fahrenheit cure.
Flexure Strength	ASTM D790	11,000 pounds per square inch minimum at 14 days and 77 degrees Fahrenheit cure.
Compressive Strength	ASTM D695	16,000 pounds per square inch minimum at 24 hours and 77 degrees Fahrenheit cure.
Bond Strength	--	Concrete shall fail before failure of epoxy.
Gel Time for 5 Mil Film	--	Four hours maximum at 77 degrees Fahrenheit.
Elongation	ASTM D638	1 percent minimum at 14 days and 77 degrees Fahrenheit.

B. Epoxy Gel: Manufacturers: One of the following or equal:

1. Sika Chemical Corp., Sikadur 31, Hi-Mod Gel.

C. Epoxy Bonding Agent: Manufacturers: One of the following or equal:

1. Master Builders, Inc., Concressive 1001 Liquid LPL.

2. Sika Chemical Corp., Sikadur 32, Hi-Mod.

3. If increased tack time is required for concrete placement, epoxy resin - Portland cement bonding agent as specified in Section 03072 may be used instead of epoxy bonding agent.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Epoxy:

1. Apply in accordance with manufacturer's installation instructions.

C. Epoxy Gel:

1. Apply in accordance with manufacturer's installation instructions.
2. Use for vertical or overhead work, or where high viscosity epoxy is required.
3. Epoxy gel used for vertical or overhead work may be used for horizontal work.

D. Epoxy Bonding Agent:

1. Apply in accordance with manufacturer's installation instructions.
2. Bonding agent will not be required for filling form tie holes or for normal finishing and patching of similar sized small defects.

END OF SECTION

SECTION 03100

CONCRETE

PART 1: GENERAL

1.01 DESCRIPTION

This section describes the submittal, material, installation, and testing requirements for furnishing and placing formwork, reinforcement, waterstops, concrete and lightweight (perlite) concrete. It also describes finishing and curing requirements, placement tolerances, and testing and repair procedures.

Except as otherwise provided herein, the design and erection shall be in accordance with the applicable provisions of ACI 318 and the concrete "Manual of Standard Practice".

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200: Earthwork

B. Section 02225: Structure Excavation & Backfill

C. Section 03480: Precast Utility Vaults and Catch Basins

D. Section 03700: Concrete Saw Cutting and Core Drilling

E. Section 05500: Metal Fabrications

F. Section 09900: Painting

1.03 GOVERNING COSTS AND STANDARDS

Furnish and installing concrete shall conform to the following:

ACI	American Concrete Institute, 318
ACI	ACI Manual of Standard Practice
CRSI	Concrete Reinforcing Steel Institute
SS90	State Standard Specification 90
ASTM	Applicable Standards

1.04 SUBMITTALS: In accordance with Section 01300.

A. Formwork Shop Drawings

1. Before starting concrete work, submit shop drawings of formwork showing size and thickness of members, dimensions and locations of openings and blockouts, vertical limits of concrete placements, horizontal lifts, plywood form pattern, proposed construction joints, form tie elevations and details, and any architectural features to be cast into the concrete. Incorporate the work of all trades. This review is for the purpose of assessing the Contractor's interpretation of the Contract Documents and will not include any considerations of the suitability, constructability, or safety of the concrete forming system.

2. Submit drawings and structural calculations for all concrete other than slabs on grade. Formwork drawings shall be signed and sealed by a Civil or Structural Engineer registered in California. Where superplastizers are used, design formwork to resist full liquid head.

3. The Contractor shall be solely responsible for the design, installation, use, and safe removal of all formwork. The formwork design shall comply with all governing codes, all Federal, State, and local ordinances; and generally accepted engineering principles.

4. Submit drawings showing the installation and removal sequence and procedures to be used. Include weight of formwork, assumed construction load, proposed minimum concrete strength for stripping of formwork, size and type of reshores, reshore spacing pattern, number of levels of reshores, and assumed load per reshore at each level.

B. Concrete

1. Prepare and submit proposed mix designs along with certified test results verifying that the components and final products meet the requirements of ACI 318 (latest edition) and these specifications.

2. Provide certificates that the cement used complies with ASTM C150 and these specifications.

3. Provide delivery tickets for ready-mix concrete or weighmaster certificates per ASTM C94, including cement weights, aggregate size, the amount of water added at the plant and record of pours. Record the amount of water added on the job on the delivery ticket. Water added at the plant shall account for moisture in both the coarse and fine aggregates.

4. Provide certificate of compliance from the manufacturer of the concrete admixtures with these specifications.

5. Provide epoxy bonding compound manufacturer's specific instructions for use. Provide manufacturer's certifications as to suitability of product to

meet job requirements with regard to surface preparation, pot life, set time, vertical or horizontal application, corrosive and/or submerged environments and forming restrictions.

C. Reinforcing Steel Shop Drawings

1. Before starting concrete work, submit drawings complying with requirements of ACI 318 (latest edition), detailed in accordance with ACI SP66, and adapted to the proposed placement schedule, showing size, dimension, bending, placing, and construction joint details. Submit drawing showing locations of all construction joints. Submit type, size, and location of all slab and bar supports. Shop fabrication shall not begin until corrected drawings bearing the Engineer's review stamp are returned in accordance with Section 01300.

2. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing reinforcing steel in accordance with the details shown on the plans and as specified.

3. Submit certified copies of mill test reports for each lot or heat of all reinforcing steel.

D. Shoring: If shoring the structure is required, submit drawings and structural calculations signed and sealed by a Civil or Structural Engineer registered in the State of California showing anticipated loads, members, connections, and anchorage of the proposed shoring system.

E. Concrete Joints and Waterstops

1. Submit manufacturer’s literature, catalog data, and statement of compliance with referenced standard and specifications for materials specified herein.

2. Submit material samples of PVC waterstops.

3. Provide technical data sheets for the Contractor’s personnel and the Owner covering joint preparation, priming, and sealant materials application.

4. Submit layouts for construction and expansion joints and proposed pour sequence. Unless otherwise noted, maximum length or width of one pour is 30 feet and a maximum area of 600 sf. Where walls meet at a corner, the maximum length of wall from the corner to a construction or expansion joint is 20 feet.

PART 2: MATERIALS

2.01 CONCRETE

A. General: Materials shall conform to State Specifications Section 90 and these specifications.

B. Portland Cement: Use domestic Portland cement that conforms to State Specifications "Type II Modified". Use only one brand of cement in any individual structure. Do not use cement that is damaged, partially set, lumpy, or caked. Reject the entire contents of the sack or container that contains such cement. Do not use salvaged or reclaimed concrete.

C. Water: Water for washing aggregates and for mixing and curing concrete shall be clean, free from oil, acid, alkalis, vegetable matter, or other deleterious substances. No salt or sea water or water containing excessive amount of sodium sulphate, magnesium sulphate or magnesium chloride shall be used.

D. Coarse Aggregate: The coarse aggregate shall consist of clean, hard, dense, tough and durable natural gravel, crushed gravel, or crushed rock, conforming to State Specifications. It shall be free from oil, organic matter or other deleterious substances.

E. Fine Aggregate: Fine aggregate shall consist of hard, durable, uncoated natural sand or other approved material, conforming to State Specifications. It shall be free from oil or other deleterious substances.

F. Fly Ash: Fly ash shall conform to ASTM A618, Class F or N, except that the loss on ignition shall be limited to 1%.

G. Admixtures

1. A water reducing agent such as Pozzolith, WRDA, or equal shall be used in all concrete. The admixture shall conform to ASTM C494. Proportioning and mixing shall be as recommended by the manufacturer.

2. Admixtures causing accelerated setting of cement in concrete shall not be used.

3. Air entraining admixtures with demonstrated compatibility with the concrete mix shall be used as required as a moderate addition to the water reducing agent to obtain the specified percent air in the resultant concrete. The Contractor shall submit data verifying that the admixtures are compatible with the mix. Air entraining admixture shall conform to ASTM C260.

2.02 REINFORCING

A. Reinforcing Steel Bars: Deformed Bars shall be in accordance with ASTM A615, including Supplementary Requirement S1, Grade 60, and free from rust, scale, oil, or frost. No. 3 bars may be Grade 40.

B. Welded Wire Fabric: Shall be of gauge and mesh size shown and shall meet the requirements of ASTM A185 or ASTM A497 for smooth wire fabric. Wire fabric shall be free from rust, scale, oil, and frost.

C. Reinforcement supported from formwork shall rest on Class 1 (plastic protected) bar supports, as specified in "Manual of Standard Practice" by the Concrete Reinforcing Steel Institute (CRSI), Chapter 3.

Reinforcement supported from the ground shall rest on 3-inch high precast concrete blocks not less than 4 inches square, and having a compressive strength equal to the specified compressive strength of the concrete being placed. The precast blocks shall have been cured as specified for concrete and shall contain soft steel wires embedded therein for fastening to the reinforcing.

D. Details of concrete reinforcement not shown on drawings shall be in accordance with CRSI Manual of Standard Practice.

E. Fibrous Reinforcing: Fibrous Reinforcing shall be 100% virgin polypropylene, MD Graded, fibers containing no reprocessed olefin materials. One and a half (1-½) pounds of fiber filaments per cubic yard shall be added at the time of batching.

1. Physical Characteristics

a. Specific Gravity: 0.91

b. Fiber Length: Multi-Design Gradation

2. Manufacturer: (or approved equal)

Fibermesh, A Division of Synthetic Industries

4019 Industry Drive

Chattanooga, TN 37416

(800) 635-2308

2.03 REINFORCING BAR COUPLERS

Reinforcing bar couplers shall be internally threaded to receive future threaded reinforcing bars or couplers. The couplers shall be cold-forged to the reinforcing bars or shall be internally threaded to receive threaded reinforcing bars. The ends of the reinforcing bars shall be upset before threading. Reinforcing bars not upset before threading may be used provided the bar size is increased one bar size. The entire assembly shall be capable of developing, in tension and compression, at least 125 percent of the specified yield strength of the bar. Provide plastic screw-caps to protect internal coupler threads.

2.04 PATCHING GROUT (Dry Pack)

Patching grout shall consist of neat Portland cement, water, and sand passing a No. 8 sieve. The ratio of cement to sand shall be one part Portland cement to two parts sand. Add sufficient water to form a damp formable consistency.

2.05 NONSHRINK GROUT

Nonshrink grout shall conform to the Corps of Engineers Specification for Nonshrink Grout, CRD-C588, and to these specifications. Use a non-gas-liberating type, cement base, premixed product requiring only the addition of water for the required consistency. Grout shall be Masterflow 713, as manufactured by Master Builders Company, Cleveland, OH, or equal.

2.06 EPOXY GROUT

The epoxy shall consist of a two-component bonding compound. Epoxy shall be Custom Building Products 100% solids epoxy, or equal.

2.07 JOINT MORTAR BED

Mortar or grout placed on horizontal construction joints shall be a mixture of cement, sand, and water in the same proportions used in the concrete but with the coarse aggregate omitted.

2.08 JOINT SEALANT

A. Joint sealant shall be a multipart, gray, non-staining, non-sagging, polyurethane sealant, which cures at ambient temperature to a firm, flexible, resilient, tear-resistant rubber. Sealant shall meet U.S. Federal Specification TT-S-002277E (3) Type 1, Class A for horizontal joints and Type II, Class A for vertical and horizontal joints and, in addition, is recommended by the manufacturer for continuous immersion in water. Sealant shall be RC 270 of Products Research and Chemical Corporation, Tremco Vulkem 227, Multi-Chem MC287, or equal.

B. Technical Requirements

Consistency	Gun grade
Tack free time	24 hours at 75 Degrees F and 50% R. H.
Pot life	1 to 3 hours
Hardness	35 shore A, +/- 5

Elongation	500%
Tensile strength ASTM D412	300 psi
Peel strength on concrete	No loss of bond after 24 hours at 150% elongation
Temperature service	-40 degrees F to 155 degrees F
Immersion in water	Continuous

2.09 BACKING ROD FOR EXPANSION JOINTS

Backing rod shall be an extruded closed-cell polyethylene foam rod, such as Minicel backer rod, manufactured by Industrial Systems Department, Plastic Products Group of Hercules, Inc., Middletown, Delaware; Ethafoam SB, as manufactured by Dow Chemical Company, Midland, Michigan; or equal.
The rod shall be ¼-inch larger in diameter than the joint width. Where possible, provide full length sections for the joint and minimize splices. Apply backing rod and bond breaker tape in expansion joints.

2.10 BOND BREAKER TAPE

Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape which will adhere to the pre-molded joint material or concrete surface. The tape shall be the same width as the joint. The tape shall be compatible with the sealant.

2.11 EXPANSION JOINT FILLERS (Walkways and Sidewalks)

Asphalt impregnated, pre-molded type, ASTM D1751, ½-inch by depth of slab minus ½-inch.

2.12 PREMOLDED JOINT FILLER

Joint filler shall be pre-formed, non-extruded type constructed of closed-cell neoprene conforming to ASTM D1752, Type I, as manufactured by W. R. Grace Company of Cambridge, MA; W. R. Meadows, Inc., Elgin, IL; or equal.

2.13 STEEL EXPANSION JOINT DOWELS

Steel expansion joint dowels shall conform to one of the following:

A. Epoxy coated steel bar dowels with a 12-mil coating thickness. Steel bar dowels shall conform to ASTM A36 or ASTM A615, plain rounds, Grade 60. Epoxy coating shall be in conformance with ASTM A775; or,

B. Stainless-steel bar dowels conforming to ASTM A276, Type 302.

2.14 EXPANDED POLYSTYRENE FILLER BLOCK

Expanded polystyrene filler blocks for future construction and expansion joints shall be Styrofoam SM brand as manufactured by Dow Chemical Company, or equal.

2.15 PREFORMED CONTROL JOINT

Preformed control joint shall be a one-piece, flexible, PVC joint former, such as Kold-Seal Zip-Per Strip KSF-150-50-50, manufactured by Omega Plastics or a one-piece steel strip with preformed groove, such as Keyed Kold Retained Kap, manufactured by Burke Concrete Accessories, Inc., San Mateo, CA, or equal. Provide the preformed control joint material in full length unspliced pieces.

2.16 PVC WATERSTOPS

Waterstops shall be extruded from a PVC compound and shall be lock-rib, center-bulb or flat-strip type as manufactured by Greenstreak, JP Specialties, Inc., or equal. Waterstop shall comply with Corps of Engineers Specification CRD-C-572. Waterstops shall be of the dimensions and profile as shown in the drawings.

Waterstops shall be extruded from virgin elastomeric PVC compound, resistant to chemical action with Portland cement, alkalies, acids, and not affected by mildew or fungi. It shall show no effect when immersed for 10 days in a 10% solution of sulfuric or hydrochloric acid, saturated lime solution or salt water. Waterstops shall be such that any cross section will be dense, homogeneous, and free from porosity and other imperfections. Waterstops shall be symmetrical in shape. When tested in accordance with Federal Standard No. 601, the material shall meet the following minimum requirements:

Minimum Requirement	ASTM Specification
Tensile Strength, 2000 psi	D638
Shore hardness A15, 60-80	D2240
Ultimate elongation, 300%	D638
Water absorption, 0.15	D570

Specific gravity, 1.3	D792
Stiffness in flexure, 1000 psi	D747
Low temperature brittleness, -35 degrees F	D746
Tear Resistance, 300 lb/in	D624

2.17 BENTONITE WATERSTOPS

Where identified on the drawings, bentonite waterstops shall be bentonite strips, Volclay "Water Stop-RX", or equal.

2.18 FLOOR HARDENER

Liqui-Hard by W.R. Meadows; Lapidolith by BASF, Inc. or equal. Hardener shall be compatible with curing method used.

2.19 ADHESIVE ANCHORS

Anchors called out on Drawings as epoxy anchor, adhesive anchor or chemical anchors shall be stainless steel threaded rods, nuts, and washers or Grade 60 rebar in two component resin adhesive. Adhesive shall be HILTI RE 500-SD, or equal. Adhesive anchors shall be suitable for submerged and corrosive environments.

2.20 STRUCTURAL ANCHORS

A. Anchors called out on the Drawings as expansion anchors (EA), expansion bolt (EB), or wedge anchor (WA) shall be Type 303 or 304 stainless steel ITW Readhead Tru Bolt, HILTI Kwikbolt TZ,or equal.

B. Adhesive anchors may be substituted for structural anchors.

2.21 CURING MATERIALS

A. Sheet Materials: ASTM C171, 4 mil polyethylene film or waterproof paper.

B. Spray Applied Membrane Forming Liquids: Meet or exceed requirements of ASTM C309, Type 1-D, Class B, except that the loss of water, when tested, shall be not more than 0.15 kilograms per square meter in 24 hours, nor more than 0.45 kilograms per square meter in 72 hours. Shall be a water-base, resin cure with fugitive dye meeting California Air Regulation Board requirements. Products by Burke, W.R. Meadows, Inc., or equal.

C. Burlap Mats: Burlap mats shall conform to AASHTO M182.

2.22 FORM TIES

A. Locate form ties on exposed surfaces in a uniform pattern or as indicated on the drawings. Construct form ties so that the ties remain embedded in the concrete except for a removable portion at each end and do not leave an open hole through the concrete. Form ties shall have conical or spherical type inserts with a maximum diameter of 1 inch. Construct form ties so that no metal is within 1 inch of the concrete surface when the forms, inserts, and tie ends are removed. Do not use wire ties. Ties shall withstand all pressures and maintain forms within acceptable deflection limits.

B. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1 inch and sufficient dimensions to permit patching of the tie hole.

Notify Engineer 48 hours prior to placement of concrete. Concrete shall not be placed until Engineer has reviewed and approved the placement of all reinforcing steel.

C. Ties for water-holding structures or dry structures with access, such as basements or pipe galleries that are below finish grade, shall have an integral steel waterstop that is tightly and continuously welded to the tie. The waterstop shall be at least two times larger in the area than the tie cross-sectional area and shall be oriented perpendicular to the tie and symmetrical about the center of the tie. Construct the ties to provide a positive means of preventing rotation or disturbance of the center portion of the tie during removal of the ends.

D. Tapered form ties shall be tapered through-bolts at least 1 inch in diameter at the smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size.

2.23 BONDING AGENT

Concresive 1001LPL, manufactured by BASF, -or approved equal

Part 3 Execution

3.01 CONCRETE MIX COMPOSITION

A. Concrete Composition: Concrete shall consist of Portland cement, fine aggregate, coarse aggregate, an air entraining agent, and water which shall conform to the requirements of Section 90 of the State Specifications, and as modified herein.

B. Submittal of Proposed Mix Design

1. The proposed mix design, with samples or rock aggregate and any admixtures to be used shall be submitted in accordance with Section 01300.

2. The grading or proportioning of the fine and coarse aggregates in the mix shall be changed whenever necessary or desirable, in the opinion of the Engineer, to secure the required economy, workability, density, impermeability or strength, and no additional compensation because of such changes shall be allowed.

C. Concrete Designations: Concrete will be designated by Class (per State Specifications), cement factor in pounds per cubic yard, or by 28 day compressive strength.

Table One

CONCRETE SUMMARY

Type of Use	Concrete Class	Maximum Aggregate Size	Minimum Compression Strength at 28 Days	Slump Inches	Max. Water Cement Ratio (by weight)	Entrained Air Required
LIQUID CONTAINING STRUCTURES:						
Slabs & Footings on grade	A	1 ½"	4000	2 to 3	0.45	4-½% ±1%
Vertical Wall Sections & Columns	A	1"	4000	3 to 4	0.45	5% ±1%
Mass Concrete & Unformed Slopes	A	1"	4000	1 to 2	0.45	5% ±1%
OTHER STRUCTURAL CONCRETE:						
Interior & Exterior Slabs, Footings, and Caissons	A	1 ½"	4000	2 to 3	0.45	4-½% ±1%
Vertical Wall Sections & Columns	A	1"	4000	3 to 4	0.45	5% ±1%
CURBS, GUTTERS, SIDEWALKS, MOWING STRIPS,	B	1"	2500	3 to 4	0.55	5% ±1%

FENCE POSTS						
PIPE BEDDING, THRUST BLOCKS, CONCRETE FILL	C	1”	2000	3 to 4	0.60	-----
LIGHTWEIGHT (PERLITE) CONCRETE	see Item 4 below	1/8”		7		5% ±1%*

D. Concrete Class

1. Class A concrete shall contain a minimum of 658 pounds of Portland cement per cubic yard.

2. Class B concrete shall contain a minimum of 470 pounds of Portland cement per cubic yard.

3. Class C concrete shall contain a minimum of 376 pounds of Portland cement per cubic yard.

4. Lightweight (perlite) concrete shall be as specified in Part 3.01 H below.

E. Concrete Compressive Strength

1. Whenever the 28 day compressive strength shown on the plans is 3,500 pounds per square inch or greater, the concrete shall be considered to be designated by compressive strength.

2. When the concrete is designated by compressive strength the mix proportions shall be determined and concrete shall be furnished which contains not less than 564 pounds and not more than 800 pounds of cement per cubic yard of concrete and which conforms to the strengths shown on the plans or as specified.

3. Batch proportions shall be adjusted as necessary to produce concrete having the specified cement factor.

F. Fly Ash

The Contractor may at his option substitute up to 15 percent by weight of fly ash for the Portland cement required herein.

G. Aggregate Sizing

1. Coarse aggregate maximum grading shall be as specified in Table 1. Grading shall be as set forth in Section 90 of the State Specifications.

2. Where the spacing of reinforcing bars is such as to result in minimum clearances, or in other locations where in the opinion of the Engineer difficulties may be experienced in pouring concrete with 1½-inch maximum size aggregate, concrete with 1-inch maximum size aggregate shall be used. In this event the air content shall be increased by ½%.

H. Lightweight (Perlite) Concrete

1. Concrete shall contain #1 size perlite, cement, water and air entraining agent. Mix design shall be 1 part cement, 6 parts perlite by volume to yield a wet density of 40.5#/ft^3 ($\pm$3#) and a dry density of 27#/ft^3 ($\pm$3#). Mix design shall be as approved by the Engineer and in strict conformance with the Perlite Institute recommendations.

2. Concrete shall have a 28-day compressive strength of 125-200 psi.

3. Thermal conductivity "k" shall be 0.58 Btu-inch/h–ft^2-F

4. Transport and placement shall be as approved by the Engineer and in strict conformance with the Perlite Institute recommendations. For example, perlite shall be added at the job site or mixer drum shall not rotate during transit.

3.02 MEASURING MATERIALS

Materials shall be measured by weighing except as otherwise specified or where other methods are specifically authorized by the Engineer. Scales shall be approved by the Engineer and have been certified by the local Sealer of Weights and Measures within one year of use. Each size of aggregate and the cement shall be weighed separately. The accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount. Cement in standard packages (sacks) need not be weighed, but bulk cement and fractional packages shall be weighed.

3.03 CONCRETE MIXING & DELIVERY

A. All concrete shall be machine mixed at the site, or delivered to the site by transit mixers under conditions approved by the Engineer.

B. No concrete shall be placed in the work after it has started to set. No concrete can be placed more than one hour after it has been mixed.

C. If transit mix is used, the rate of delivery, haul time, mixing time and hopper capacity shall be such that all mixed concrete delivered shall be placed in the forms within one hour from the time of introduction of cement and water to the mixer. All concrete shall be kept continuously agitated until discharged in the hopper at the job site.

D. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C94 and Chapter 7 of ACI 301. Plant equipment and facilities shall conform to the "Check List for Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.

3.04 CONCRETE HANDLING & PLACEMENT

A. Excavations and Formwork

1. Excavations shall be kept free from water while concrete is being placed, cured and finished therein. Fresh concrete shall be protected at all times from running water.

2. The order of placing concrete in all parts of the work shall be acceptable to the Engineer. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 days for hydraulic structures and 2 days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 days for hydraulic structures and 4 days for all other structures.

3. Before placing concrete, all form work shall be cleaned of dirt and construction debris, water drained, reinforcement securely and properly fastened in its correct position, forms at construction joints re-tightened, all ducts, sleeves, hangers, pipes, conduits, bolts, wires, etc., installed. No concrete shall be placed before the forms and all work that is to be embedded have been set and observed by the Engineer.

B. Concrete Placement

1. The working schedule and schedule of placement shall be as shown on the plans and worked out in conjunction with the Engineer. The schedule shall be worked out prior to commencement of work, and shall be rigidly adhered to.

2. Concrete shall be conveyed from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent the separation or loss of the materials. The concrete shall be deposited in the forms as nearly as

practicable in its final position to avoid rehandling.

3. Concrete shall be placed and consolidated by methods that will not cause segregation of the aggregates and will result in a dense homogeneous concrete which is free of voids and rock pockets. All concrete shall be used while fresh and before it has taken an initial set. Retempering any partially hardened concrete with additional water will not be permitted.

4. Surfaces on which concrete is to be placed shall be dampened with water immediately before placing concrete.

5. Concrete shall not be deposited on frozen or ice-coated ground nor on ice-coated forms, reinforcing steel, embedded items or construction joints.

6. Where pavement or surfacing is to be placed around or adjacent to manholes or drainage inlets which will be located within traffic lanes, such structures shall not be constructed to final grade until after the pavement or surfacing has been placed around these locations.

7. Where a schedule for placing concrete is shown on the plans no deviation will be permitted therefrom unless approved in writing by the Engineer.

8. Mixed concrete, after being deposited, shall be consolidated until all voids are filled and free mortar appears on the surface. The concrete shall be placed as nearly as possible in its final position and the use of vibrators for extensive shifting of the mass of fresh concrete will not be permitted.

   Except for concrete used in cast in place piles, fresh concrete shall not be permitted to fall from a height greater than 4 feet without the use of adjustable length pipes, tubes or double belting placed to prevent segregation of the concrete. Double belting shall not be used unless the thickness of the member is less than 16 inches.

9. In vertical sections, concrete shall be deposited continuously in horizontal layers of 24 inches maximum depth so as to maintain a horizontal plastic surface until the completion of the unit. No concrete shall be deposited on concrete which has hardened sufficiently to cause the formation of seams and planes of weakness within the section.

10. Concrete for horizontal members or sections shall not be placed until the concrete in the supporting vertical members or sections is no longer plastic and has been in place at least two hours.

11. In all slabs, concrete shall be deposited in a continuous or monolithic operation to the full thickness of the slab. Each batch shall be dumped against previously placed concrete and not away from it, and shall not be

dumped in separate piles and then worked together.

12. The concrete in each integral part of the structure shall be placed continuously, and work will not be allowed to commence on any such part unless sufficiently inspected and approved material for the concrete is on hand, and forces and equipment are sufficient to complete the part without interruption in the placing of the concrete.

C. Concrete Vibrating

1. Consolidate concrete by means of high frequency internal vibrators within 15 minutes after it is deposited in the forms. The vibrators shall not be attached to or held against the forms or the reinforcing steel. The vibrating shall be done with care and in such manner that displacement of reinforcement, ducts, and embedded items is avoided.

2. All concrete shall be consolidated by vibration so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators used shall be the largest size and the most powerful that can be properly used in the work, as described in Table 5.1.4 of ACI 309. They shall be operated by competent workmen. Use of vibrators to transport concrete within forms shall not be allowed. The vibrator shall be inserted vertically at uniform spacing over the entire area of the placement. The distance between insertions shall generally be about 1½ times the radius of action, or such that the area visibly affected by the vibrator overlaps the adjacent just vibrated area by a few inches. In slabs, the vibrator shall be sloped toward the horizontal as necessary to operate in a fully embedded position.

3. The vibrator shall penetrate rapidly to the bottom of the layer, and at least 6 inches into the preceding layer if there is such. At each insertion, the vibrator shall be held stationary for a time sufficient to consolidate the concrete but not cause segregation, generally from 5 to 15 seconds. The vibrator shall then be withdrawn slowly, at the rate of approximately 3 inches per second.

4. A spare vibrator in good working condition shall be kept on the job site during all concrete placing operations. Where the concrete is to have an as cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented, if necessary, by spading to work the coarse aggregate back from the formed surface.

5. The use of external vibrators for consolidating concrete will be permitted when the concrete is inaccessible for adequate consolidation provided the forms are constructed sufficiently rigid to resist displacement or damage

from external vibration.

D. Cold Weather Requirements

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather in accordance with ACI 306 and the following paragraphs.

2. When the temperature of the surrounding atmosphere is 40 degrees F or is likely to fall below this temperature, use heated mixing water not to exceed 140 degrees F. Do not allow the heated water to come in contact with the cement before the cement is added to the batch.

3. When placed in the forms during cold weather, maintain concrete temperature at not less than 55 degrees F for the first five days after placing, and above 35 degrees F for the remainder of the curing period. Provide thermometers to indicate the ambient temperature and the temperature 2 inches inside the concrete surface.

4. There will be no additional reimbursement made to the Contractor for costs incurred for placing concrete during cold weather.

E. Hot Weather Requirements

1. During hot weather, give proper attention to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation in accordance with ACI 305 and the following paragraphs.

2. When the weather is such that the temperature of the concrete as placed would exceed 90 degrees F, use ice or other means of cooling the concrete during mixing and transportation so that the temperature of the concrete as placed will not exceed 90 degrees F.

3. Take precautions when placing concrete during hot, dry weather to eliminate early setting of concrete. This includes protection of reinforcing from direct sunlight to prevent heating of reinforcing, placing concrete during cooler hours of the day, and the proper and timely application of specified curing methods.

4. There will be no additional reimbursement to the Contractor for costs incurred for placing concrete in hot weather.

3.05 BONDING TO EXISTING CONCRETE

Coat the contact surface with epoxy bonding compound. The method of preparation and application of the bonding compound shall conform to the manufacturer's printed

instructions and recommendations for specific application of the product.

3.06 FORMWORK

A. Arrange formwork construction to allow for proper sequencing and removal without damage. Use orderly and symmetrical panel arrangement with minimum number of joints. Before proceeding, secure approval of formwork and procedures.

B. Lumber, prefabricated wood panels, metal, or plastic lined panels shall be sound and free from any defects that will mar or detract from the surface of the finished concrete. Construct forms sufficiently tight to prevent loss of mortar. Design forms to withstand vibrator action. Treat forms with a non-staining material to eliminate absorption of water and to act as a form release agent.

C. Thoroughly remove all dirt, mortar, and foreign matter before each use. Where the bottom of the form is inaccessible from within, provide access panels to permit thorough removal of extraneous material before placing concrete.

D. Kerf wood forms inserted for architectural treatment to accommodate swelling without pressure on the concrete.

E. Chamfer all exposed horizontal and vertical edges or other corners ¾-inch, both interior and exterior of structures.

F. Earth trench forms for walls and footings below existing and final grades may be used, if approved after inspection of the trenches, provided the sides are clean, even, vertical, true, and provided the bottoms are level, clean, and without fill, and the width is increased two (2) inches.

G. Where tolerances are not shown elsewhere, permissible deviations from established lines, grades, and dimensions are listed below:

1. Variation from the Plumb

a. In the lines and surfaces of columns, piers, walls and in arises: in 10 feet, ¼-inch; in any story or 20 feet maximum, 3/8-inch; in 40 feet or more, ¾-inch.

b. For exposed corners and other conspicuous lines: in any bay or 20 feet maximum, ¼-inch; in 40 feet or more, ½-inch.

2. Variation from the Level or from the Grades Shown

a. In floors, ceilings, and beam soffits: in 10 feet, ¼-inch; in any bay or 20 feet maximum, 3/8-inch; in 40 feet or more, ¾-inch; in floors to receive tile, maximum of 1/8" in 10 feet.

b. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines: in any bay or 20 feet maximum, ¼-inch; in 40 feet or more, ½-inch.

3. Variation of the linear building lines from established position in plan and related position of columns, walls and partitions: In any bay or 20 feet maximum, ½-inch; in 40 feet or more, 1 inch.

4. Variation in tank, channel or structural lines in 10 feet, ¼-inch; in 20 feet, 3/8 inch; in 40 feet or more, ½-inch.

5. Variation in the sizes and locations of sleeves, floor openings and wall openings: ¼-inch.

6. Variation in cross-sectional dimensions of columns, beams and piers, and in the thickness of slabs and walls: minus, ¼-inch; plus, 3/8-inch.

7. Footings

a. Variation in Dimensions in Plan: Minus, ½-inch; plus, 2-inch.

b. Misplacement or Eccentricity: 2 percent of the footing width in the direction of misplacement but not more than 2 inches.

c. Misplacement or Eccentricity of Footings Supporting Masonry Or Concrete: ½-inch.

d. Reduction in Thickness: Minus 5 percent of specified thickness.

8. Variation In Steps

a. In a Flight of Stairs: rise, 1/8-inch; tread, ¼-inch.

b. In Consecutive Steps: rise, 1/16-inch; tread, 1/8-inch.

9. Variation from established lines and grades in sidewalks, plazas, outdoor concrete slabs, curb and gutter sections: in 10 feet, ¼-inch; in 1 foot, 1/8-inch.

Where tolerances are not met, the Owner's Representative may require removal and replacement at no cost to the Owner.

3.07 REINFORCEMENT

A. Design: The reinforcement design shown on drawings shows only the necessary information for detailing the reinforcement and preparing placing and bending details. Prior to starting concrete work, submitted detailed shop drawings shall be

approved.

B. Bending: In accordance with CRSI Manual of Standard Practice, Chapter 7.

C. Placement: Place reinforcement accurately as shown. Adequately secure metal reinforcement in position by concrete or metal chairs and spacers, in accordance with CRSI Manual of Standard Practice, Chapter 8. Distance between the steel and the surface, as shown; otherwise, in accordance with Chapter 8. In walls, use bolsters between form and reinforcement to prevent lateral displacement of reinforcement and to insure proper concrete cover.

D. Splices: Locate splices of reinforcement as shown. For any splices not shown, assume Class B splice. Stagger splice in adjacent horizontal bars. Lap adjacent sheets of wire mesh a minimum of 6 inches and wire securely.

E. Inspection: After reinforcement has been placed, it shall be inspected and approved before placing concrete.

F. Conditions of Surfaces: At time concrete is placed, all metal reinforcement shall be free from rust, scale, frost, or other coatings that would destroy or reduce the bond.

G. Welding Reinforcement: Do not weld reinforcing steel unless specifically approved by the Engineer. Welding to be in accordance with ASTM A706.

3.08 JOINTS AND EMBEDDED ITEMS

A. Construction Joints

1. Obtain approval for joints not shown and locate them where they least impair the strength of the structure. Unless otherwise shown on the drawings, joints in walls and columns shall be at the underside of floors, slabs or beams, and at the top of footings or floor slabs. Place beams at the same time as slabs. At least two hours shall elapse after depositing concrete in columns or walls before depositing concrete in supported beams or slabs. As the new concrete is placed, re-vibration in tops of columns and walls is desirable. Make joints perpendicular to the main reinforcement.

2. All horizontal construction joints in walls shall have a continuous wood screed strip at the outer face of joint to form a true line. Screeds shall be removed and the reglet thoroughly cleaned out before pouring the next portion of wall.

3. Continue all reinforcing steel and mesh across construction joints.

4. Construction joints shall be made rough and all laitance removed from the

surface by chipping the entire surface, sandblasting with coarse silica sand, or hosing the surface 4 to 6 hours after the pour with a fine spray, exposing solidly embedded clean aggregate.

Forms and reinforcing shall likewise be cleaned of drippings, debris, etc., by means of compressed air. Surfaces of the hardened concrete shall be cleaned to the satisfaction of the Engineer and wet as required before placing of new concrete. Just before starting the new pour, all free water shall be removed and the horizontal surfaces shall be covered with at least a 4-inch thickness of concrete composed of cement and fine aggregate, omitting the coarse aggregate.

B. Expansion Joints

1. Install expansion joint fillers to ½-inch below slab.

2. Where shown, load transfer dowels shall consist of plain bars with one half coated with an approved anti-bond coating. The coated half shall be sleeved. No other reinforcement or metal shall extend continuously through the joint.

C. Waterstops

1. The design and location of waterstops shall be as shown on the drawings and in these specifications. Each piece of pre-molded waterstop shall be of maximum practicable length to minimize the number of end joints.

2. PVC waterstops shall be properly heat spliced at the ends and intersections to ensure continuity. Construct forms for construction joints in such a manner as to prevent injury to waterstops. Allow at least 10 minutes before pulling or straining the new splice in any way. The finished splices shall provide a cross section that is dense and free of porosity with tensile strength of not less than 80% of the unspliced materials.

3. Install waterstops in strict conformance with manufacturer's recommendations.

4. Support waterstops securely against displacement using approved adhesives, or methods specifically recommended by the manufacturer. Hold PVC waterstops securely in position in the construction joints by wire ties, continuous bars, and rings as necessary and approved by the Engineer. Install waterstops in construction and expansion joints in hydraulic structures or where shown in the drawings.

5. If joint is not watertight after construction, one or both of the following shall be done to provide a watertight joint:

a. Grouting of the joint by drilling grout holes to the center of the structure unit and forcing epoxy grout into the joint under pressure.

b. Cutting of a bevel groove on the water side of the joint. The groove shall be ½ to ¾-inch in width and depth and shall be caulked with epoxy joint sealer in accordance with manufacturer's instructions.

D. Other Embedded Items

1. Prior to concreting, place all required sleeves, inserts, anchor bolts and embedded items.

2. Give all trades whose work is related to the concrete ample notice and opportunity to introduce embedded items before concrete is placed.

3. Position expansion joint material, waterstops, and embedded items accurately and support them against displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with readily removable material to prevent the entry of concrete.

E. Pipes and Wall Spools Cast in Concrete

1. Install wall spools (i.e. bell ring inserts), wall flanges, and wall anchors before placing concrete. Do not weld, tie, or otherwise connect the wall spools or anchors to the reinforcing steel.

2. Support pipe and fabricated fittings to be encased in concrete-on-concrete piers or pedestals. Carry concrete supports to firm foundations so that no settlement will occur during construction.

3. Pipes or spools located below operating water level shall have waterstop ring collars and shall be cast in place. Do not block out such piping and grout after the concrete section is cast. Pipes fitted with thrust rings shall be cast in place.

F. Additional Reinforcement Around Openings

Place additional reinforcement around pipe or openings as indicated in the drawings

3.09 FORM REMOVAL

Carefully remove forms to ensure the complete safety of the structure. Where the structure is supported by shoring, the beam sides, columns, or other vertical forms may be removed after 36 hours, providing the concrete will not be injured. All supporting forms shall remain in place for a minimum of 10 days. Do not remove supporting forms

or shoring until members have acquired sufficient strength to support their weight and imposed loads safely.

3.10 CONSTRUCTION LOADS ON STRUCTURAL SLABS

If shoring is removed, no construction materials and equipment shall be allowed on structural slabs until the concrete has reached the 28 day- compressive strength. All superimposed construction loads will then be limited to the design load of the slab.

3.11 REPAIRING AND PATCHING

A. Clean, thoroughly dampen and patch all tie holes and all repairable defects immediately after form removal.

B. All honeycombed and other defective concrete shall be removed to sound concrete with edges perpendicular to the surface. Surface imperfections greater than 3/8 inch in any dimension shall be removed and the affected areas neatly patched. Dampen the area to be patched and an area at least 6 inches wide surrounding it to prevent absorption of water from the patching mortar. Mix patching grout to the consistency of thick cream and brush it well into the surface.

C. Make the patching mortar of the same material and approximately the same proportions as used for the concrete, omitting the coarse aggregate. The resultant mortar shall consist of not more than 1 part cement to 2½ parts sand by damp loose volume.

D. Do not use more mixing water than necessary for handling and placing. Mix the patching mortar in advance and allow to stand with frequent manipulation with a trowel, without adding water, until it has reached the stiffest consistency that will permit placing.

E. After surface water has evaporated from the area to be patched, brush the patching grout well into the surface. When the patching grout begins to lose the water sheen, apply the premixed patching mortar. The mortar shall be thoroughly consolidated into place and struck off to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, leave the patch undisturbed for at least 1 hour before finishing it. Keep the patched area damp for 7 days. Do not use metal tools in finishing a patch in a formed wall which will be exposed.

F. Tie Holes: Clean thoroughly, dampen, then fill solid with patching mortar. Mortar shall match color of concrete. Fill tie holes prior to finishing.

3.12 FINISHES FOR SURFACES

A. Finish 1: Beams, columns, and exterior walls not exposed to water or view: Repair defective concrete, fill depressions deeper than ½ inch, and fill tie holes.

B. Finish 2: Exterior and interior walls, beams, and columns exposed to water, unless such items are to be coated: Repair defective concrete, remove fins, fill depressions ¼ inch or deeper, and fill tie holes.

C. Finish 3: Walls, beams, and columns of structures or buildings exposed to view and to 1 foot below water level or finished grade; underside of formed floors or slabs (EXCEPT - surfaces which are to be coated): In addition to Finish 2, fill depressions and airholes with mortar. Dampen surfaces and then spread a slurry consisting of one part cement and one and one-half parts sand by damp loose volume, over the surface with clean burlap pads or sponge rubber floats. Remove any surplus by scraping and then rubbing with clean burlap (sacked finish).

D. Finish 4: Exterior and interior surfaces to be coated: Repair defective concrete, remove fins, fill depressions 1/16 inch or deeper, fill tie holes, remove mortar spatter, and remove bulges higher than 1/16 inch. Surface shall be trowelled, sacked, and brush blasted.

E. Finish 5: Slabs and floors to be covered with concrete or grout: Screed to grade without special finish.

F. Finish 6: Slabs and floors not water bearing: Repair defective concrete, remove fins, fill depressions ¼ inch or deeper, and fill tie holes.

G. Finish 7: Slabs and floors which are water bearing; Slab surfaces on which mechanical equipment moves; Slab surfaces to receive hardener: Steel trowel finish, free from trowel marks and all irregularities.

H. Finish 8: Slabs and floors of structures or buildings exposed to view: Steel trowel finish without local depressions or high points and apply a light hair-broom finish. Do not use stiff bristle brooms or brushes. Leave hair-broom lines parallel to the direction of slab drainage.

I. Finish 9: Slabs and floors at slopes greater than 10% and stairs: Steel trowel finish without local depressions or high points. Apply a coarse broom finish. Leave broom lines parallel to the direction of slope drainage.

J. Finish 10: Exposed stairs and landings and slabs designated for non-slip finish: Areas to have non-slip finish shall incorporate 25 pounds per 100 square feet of aluminum oxide grains into the surface. Immediately before floating begins, sprinkle two thirds (2/3) of the abrasive evenly over the surface and float. After embedment, sprinkle the remaining one third (1/3) at right angles to the previous application. Apply more heavily in areas not sufficiently covered by the first application, and float again immediately. Complete finishing as specified under Trowelled Finish.

K. Finish 11: Exposed edges (EXCEPT – edges normally covered with earth):

Provide chamfer or beveled edges per this Section.

L. Finish 12: Top of walls, beams, and similar unformed surfaces: Strike smooth and float in accordance with Finish 4.

3.13 SLAB FINISHING

A. Screeding: After concrete has been thoroughly consolidated, screed slabs to the desired elevation and contours by means of accurately placed edge forms and intermediate screed strips.

B. Floated Finish

1. Place, consolidate, strike off, and level concrete, but do not work it further until ready for floating. Begin floating when water sheen has disappeared and when the surface has stiffened sufficiently.

2. During or after the first floating, check planeness of surface with a 10-foot straightedge applied at not less than two different angles, and then cut down all high spots and fill all low spots to achieve a true plane within ¼-inch in 10 feet.

3. Refloat slab immediately to a uniform sandy texture.

C. Troweled Finish: Float finish slab as described above, then steel trowel by machine or by hand. Additional troweling shall be done by hand after the surface has hardened sufficiently. Final trowelling shall produce a ringing sound from the trowel and the finished surface shall be free of trowel marks, uniform in texture, and appearance shall be planed to the tolerance specified under Floated Finish. Trowelled finish shall occur at tank floors (except where grout topping or fillets will follow), troughs, channels, clear wells, and all building floor slabs.

D. Coarse Broom Finish: Immediately after floating, give slabs for exterior walkways and exterior stoops a coarse transverse scored texture by drawing a broom across the surface.

3.14 FLOOR HARDENER

A. All building floors not scheduled for floor covering, Non-slip Floor Finish, or Broom finish shall receive hardener (Finish 7).

B. Apply hardener after floors have cured, in accordance with the manufacturer's recommendations.

C. Floors shall receive three applications of hardener, mixed and applied as specified for heavy duty floors.

3.15 CURING AND PROTECTION

A. General: Beginning immediately after placement, protect concrete from drying, excessively hot and cold temperatures and mechanical injury. Keep moisture loss to a minimum until cement has hydrated and concrete is hard. Keep concrete constantly moist during the curing period. Follow color admixture manufacturer's recommendations for integrally colored concrete.

B. Curing

1. Formed Surfaces: Keep forms wet. Cool metal forms exposed to the sun with water. Forms shall remain in place for 7 days unless material specified for in Section 2.21 Curing Materials is applied. If curing compound is used, apply in accordance with manufacturer's instructions. Curing compound shall not be used on any wall/slab scheduled to be coated.

2. Slabs: Immediately after finishing, apply one of the materials specified in Section 2.21 entitled Curing Materials, but use membrane forming liquid only with Engineer's approval.

3. Duration of Curing: 7 days minimum.

C. Protection

1. In cold weather, maintain the moisture conditions but also, by heating or covering, maintain the temperature of the concrete between 50 degrees F and 70 degrees F for entire curing period.

2. In hot weather take immediate steps to protect newly finished concrete from drying effects of wind and sun, and maintain temperature of the air surrounding the concrete uniform within 5 degrees F in any one hour or 50 degrees F in any 24-hour period.

3. During curing period, protect concrete from mechanical damage, loading, shock and vibration.

3.16 CONSTRUCTION OF CONCRETE FILLETS, TOPPING, AND EQUIPMENT PADS

A. Concrete fillets, topping and equipment pads shall be placed as soon as possible after completion of the curing period of the tank walls and structural floors. Contact surfaces shall be thoroughly cleaned to the degree recommended by the bonding agent manufacturer.

B. Bonding agent shall be accurately and thoroughly mixed and applied at the manufacturer's recommended coverage rate. Mix only the amount which can be used prior to expiration of the pot life. Concrete shall be immediately placed over

the fresh surface before setting of the agent. Bonding agent which sets up prior to placing concrete shall be recoated with a fresh coat.

C. Concrete fillets, topping, and equipment pads shall be accurately screeded to the slopes and elevations shown and steel trowel finished. Cure concrete as specified for slabs above. Set equipment anchor bolts in pad to accommodate equipment furnished.

3.17 BACKFILL AGAINST STRUCTURES

A. Backfill against concrete structures shall not be allowed until the concrete has reached the specified 28-day compressive strength. Where backfill is to be place on both sides of the wall, or against more than one wall of a structure, place the backfill uniformly on both sides of the wall or walls.

Do not backfill until structure has passed leakage testing.

B. Do not backfill the walls of structures that are laterally restrained or supported by suspended slabs or slabs on grade until the slab is poured and the concrete has reached the specified compressive strength.

3.18 NONSHRINK GROUT

Use nonshrink grout to fill sleeves and voids under equipment bases. Grout shall be mixed and used in accordance with manufacturer's recommendations. Exposed edges shall be smooth, straight and even.

3.19 ADHESIVE ANCHORS

Install in strict conformance to manufacturer's printed instructions. Do not cut or damage existing reinforcing bars. Where reinforcing bars are encountered, move anchor location or core hole as approved by the Engineer.

3.20 LEAKAGE TESTING OF HYDRAULIC STRUCTURES

A. General

1. Prior to backfilling the structure and the application of water-proofing coatings, hydrostatically test reinforced concrete structures which will contain water or fluid to determine that they conform to Section B herein and are free of detectable leaks. Do not start leak testing or cleaning of surfaces until concrete is cured and joint sealants have set and cured a minimum of 14 days. Do not hydrostatically test walls which are to be restrained or laterally supported by slabs until slab concrete has obtained the specified compressive strength.

2. Prior to testing, clean exposed surfaces by thoroughly hosing and

removing surface laitance and loose matter from walls and slabs. Remove wash water and debris from the structures by means other than washing through plant piping.

B. Leakage Test Procedure

1. Fill hydraulic structures to be subjected to leakage tests with potable water to the normal operating liquid level line not less than 2 feet below top of walls. Filling shall be at a uniform rate over a 24-hour period with continuous monitoring. For structures with adjacent bays, fill all bays simultaneously. Empty adjacent bays alternately. Repair any running leaks which appear during filling before continuing.

2. After the structure has been kept full for 48 hours, it will be assumed for the purposes of the test that the absorption of moisture by the concrete in the structure is complete. Then close all valves and gates to the structure and measure the change in water surface each day for a five-day period.

3. During the test period, examine exposed portions of the structure, and mark visible leaks or damp spots. A damp spot is defined as an area which seeps sufficient moisture to dampen a paper towel when pressed against it. Repair visible leaks or damp spots after dewatering. Additionally, if the drop in water surface in the 24-hour period exceeds 1/10 of 1% of the normal volume of liquid contained in the structure, the leakage shall be considered excessive.

4. The determination of surface moisture evaporation shall be aided with a 24-inch deep, white colored, watertight container with not less than 10 square feet of surface area exposure. Position container to experience environmental conditions similar to the structure being tested. Subtract the water loss due to evaporation from the measured water loss in the structure to determine the water loss due to leakage.

5. If the leakage is excessive, drain the structure, repair leaks and damp spots, and refill the structure and again test for leakage. Continue this process until the drop in water surface in a 24-hour period meets the test requirements.

6. If an underdrain system is present, inspect the manholes of the underdrain system for evidence of leaks in the floor slabs. If leaking is indicated, locate and repair.

7. Seed the floor slab of each hydraulic structure with one sack of cement per 1,000 square foot surface area. Seeding shall take place after the test filling has reached 18 inches in depth. Detect leaks in construction and

expansion joints with the aid of a diver. Stir cementious deposits flowing toward leaks and repair where the defect is located.

8. Repair flowing leaks whether leakage exceeds the allowable leakage or not.

9. Repairs and additional filling and testing shall be made by the Contractor at no additional cost to the Owner.

C. Repair of Defects

1. Do not repair defects until concrete has been reviewed by the Owner's Representative.

2. Surface Defects: Repair surface defects that are smaller than 1 foot across in any direction and are less than ½ inch in depth. Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges perpendicular to the surface and at least 3/8 inch deep, thoroughly dampen the surface, work into the surface a bonding grout, fill the hole with mortar, match the finish on the adjacent concrete, and cure as specified.

3. Severe Defects: Repair severe defects that are larger than surface defects but do not appear to affect the structural integrity of the structure. Repair by removing the honeycombed and other defective concrete down to sound concrete, make the edges perpendicular to the surface, sandblast the surface, coat the sandblasted surface with epoxy bonding compound, place nonshrink grout as specified herein, match the finish on the adjacent concrete, and cure as specified.

4. Major Defects: If the defects are serious or affect the structural integrity of the structure or if patching does not satisfactorily restore the quality and appearance to the surface, the Engineer may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section at no additional cost to the Owner.

D. Repair of Cracks in Concrete

1. Repair leaking concrete cracks that are 1/10 inch or less in width by epoxy pressure injection.

a. Preparation: Insert and anchor a one-way polyethylene valve or pipe nipple in holes drilled into crack. Position them every 6- to 18-inches on center depending on the width of crack. Maintain a slow, steady pressure rather than a rapid buildup of pressure.

When grouting material reaches the next tube, stop off the present position and follow the same procedure on the next position.

b. Upon completion of the epoxy grouting, remove the epoxy gel used to hold the valve or nipple by applying a direct flame to the epoxy and scraping it off. Fill the holes with the same material as used for patching the surface.

c. While the valves or nipples are installed first, the grouting operation shall not commence until after the patch work has been completed and has sufficiently cured.

2. Repair cracks in concrete structures that are wider than 1/10 inch in width by cutting out a square edged and uniformly aligned joint 3/8 inch wide by ¾ inch deep, preparing exposed surfaces of the joint, priming the joint, and applying polyurethane joint sealant in accordance with this section.

3. If the cracks are serious or affect the structural integrity or function of the element, the Engineer may require the concrete to be removed and replaced, complete, in accordance with the provisions of this section at no additional cost to the Owner.

4. After repairing visible leaks, damp spots or leaking concrete cracks, retest the structure.

3.21 CONCRETE TESTING

A CERTIFIED testing laboratory, at Owner's expense shall perform the following concrete testing:

A. One set of four concrete test cylinders shall be taken for every 50 cubic yards or fraction thereof of each concrete mix design placed each day. The Engineer has the option to direct the required test specimens to be taken as he deems necessary to ensure the concrete meets the specification.

B. Specimens shall be taken, cured, and tested for compressive strength in accordance with ASTM C31, ASTM C39, and ASTM C172, respectively.

C. Test one cylinder at 7 days for information; test two cylinders at 28 days for acceptance; and hold one cylinder for verification. Strength acceptance will be based on the average of the strengths of the two cylinders tested at 28 days. If one cylinder of a 28-day test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use the fourth cylinder for the test result.

D. Determine the concrete slump by ASTM C143 with each strength test sampling and as required to establish consistency.

E. Determine air content of the concrete using ASTM C231 to verify the percentage of air in the concrete immediately prior to depositing in the forms.

F. Test reports shall be sent to the Engineer with copies to the Contractor.

G. The average value of concrete strength tests shall be equal to or greater than the specified 28-day strength. No test shall be less than 90% of the specified 28-day strength.

H. If the 28-day strength tests fail to meet the specified minimum compressive strength, the concrete will be assumed to be defective and one set of three cores from each area may be taken as selected by the Owner and in accordance with ASTM C42. If the average compressive strength of the set of three concrete cores fails to equal 90% of the specified minimum compressive strength or if any single core is less than 75% of the minimum specified compressive strength, the concrete will be considered defective. The Owner may require additional coring, nondestructive load testing, or repair of defective concrete. Costs of coring, testing of cores, load testing, and required repairing pertaining thereto shall be paid by the Contractor at no extra cost to the Owner.

3.22 DAMAGED OR DEFECTIVE CONCRETE

Remove damaged or defective concrete before completion and acceptance of the work and replace with acceptable concrete, at no additional cost to the Owner.

END OF SECTION

SECTION 03110

CONTROLLED LOW STRENGTH MATERIAL

PART 1 GENERAL

1.1 SUMMARY

Section Includes: Controlled Low Strength Material (CLSM).

1.2 RELATED SECTIONS:

A. Section 02225 – Structure Excavation and Backfill

B. Section 03100 - Concrete

1.3 REFERENCES

American Society of Testing and Materials (ASTM):

A. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

B. C33 - Standard Specification for Concrete Aggregates.

C. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

D. C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.

E. C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

F. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

G. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

H. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m3))

1.4 SYSTEM DESCRIPTION

Performance Requirements:

A. Total Calculated Air Content: Not be less than 8.0 percent nor greater than 12.0 percent.

B. Minimum Unconfined Compressive Strength: Not less than 50 pounds per square inch measured at 28 days.

C. Maximum Unconfined Compressive Strength: Not greater than 150 pounds per square inch measured at 28 days.

D. Wet Density: No greater than 132 pounds per cubic foot.

1.5 SUBMITTALS

A. Product Data: Submit data completely describing products.

B. Sieve Analysis: Submit sieve analyses of fine and coarse aggregates being used in triplicate. Resubmit at any time there is a significant change in grading of materials.

C. Mix: Submit full details, including mix design calculations for mix proposed for use.

D. Trial Batch Test Data:

1. Submit data for each test cylinder.
2. Submit data that identifies mix and slump for each test cylinder.

E. Cement Mill Tests: Include alkali content, representative of each shipment of cement for verification of compliance with specified requirements.

F. Pozzolan Certificate of Compliance: Identify source of pozzolan and certify compliance with requirements of ASTM C 618.

PART 2 MATERIALS

2.1 MATERIALS

A. Portland Cement: Type II modified Portland cement as specified in Section 03100.

B. Fly Ash: As specified in Section 03100.

C. Water: As specified in Section 03100.

D. Admixture: Air entraining admixture in accordance with ASTM C260.

E. Fine Aggregate: Concrete sand that does not need to be in accordance with ASTM C33. No more than 12 percent of fine aggregate shall pass a No. 200 sieve, and no plastic fines shall be present.

F. Coarse Aggregate: Pea gravel no larger than 3/8 inch.

2.2 MIXES

Suggested Design Mix

Material	Weight	Specific Gravity	Absolute Volume Cubic Foot
Cement	40 pounds	3.15	0.15
Fly Ash	300 pounds	2.30	2.09
Water	283 pounds	1.00	4.54
Coarse Aggregate	1,465 pounds	2.68	8.76
Fine Aggregate	1,465 pounds	2.68	8.76
Admixture	4-6 ounces		2.70
TOTAL	3,543 pounds		27.00

2.3 SOURCE QUALITY CONTROL

A. Trial Batch:

1. After mix design has been accepted by Engineer, have trial batch of the accepted mix design prepared by testing laboratory acceptable to Engineer.

2. Prepare trial batches using specified cementitious materials and aggregates proposed to be used for the Work.

3. Prepare trial batch with sufficient quantity to determine slump, workability, consistency, and to provide sufficient test cylinders.

B. Test Cylinders:

1. Prepare test cylinders in accordance with ASTM C31 with the following exceptions:

   a. Fill the concrete test cylinders to overflowing and tap sides lightly to settle the mix.

   b. Do not rod the concrete mix.

   c. Strike off the excess material.

2. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage. Do not remove the test cylinder from mold until the cylinder is to be capped and tested.

3. Do not remove the test cylinder from mold until the cylinder is to be capped and tested.

4. The test cylinders may be capped with standard sulfur compound or neoprene pads:

   a. Perform the capping carefully to prevent premature fractures.

   b. Use neoprene pads a minimum of 1/2 inch thick, and 1/2 inch larger in diameter than the test cylinders.

   c. Do not perform initial compression test until the cylinders reach a minimum age of 3 days.

C. Compression Test 8 Test Cylinders: Test 4 test cylinders at 3 days and 4 at 28 days in accordance with ASTM C39 except as modified herein:

1. The compression strength of the 4 test cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength.

D. If the trial batch tests do not meet the Specifications for strength or density, revise and resubmit the mix design, and prepare additional trial batch and tests. Repeat until an acceptable trial batch is produced that meets the Specifications.

1. All the trial batches and acceptability of materials shall be paid by the Contractor.

2. After acceptance, do not change the mix design without submitting a new mix design, trail batches, and test information.

E. Determine Slump in Accordance with ASTM C143 with the Following Exceptions:

1. Do not rod the concrete material.

2. Place material in slump cone in one semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.

PART 3 EXECUTION

3.1 INSTALLATION

A. Prior to placement, soils located below controlled low strength material placement shall be prepared per Specification 02225.

B. Place controlled low strength material by any method which preserves the quality of the material in terms of compressive strength and density:

1. Limit lift heights of CLSM placed against structures and other facilities that could be damaged due to the pressure from the CLSM, to the lesser of 3 feet or the lift height indicated on the Drawings. Do not place another lift of CLSM until the last lift of CLSM has set and gained sufficient strength to prevent lateral load due to the weight of the next lift of CLSM.

2. The basic requirement for placement equipment and placement methods is the maintenance of its fluid properties.

3. Transport and place material so that it flows easily around, beneath, or through walls, pipes, conduits, or other structures.

4. Use a slump of the placed material greater than 9 inches, and sufficient to allow the material to flow freely during placement:

a. After trial batch testing and acceptance, maintain slump developed during testing during construction at all times within plus or minus 1 inch.

5. Use a slump, consistency, workability, flow characteristics, and pumpability (where required) such that when placed, the material is self-compacting, self-densifying, and has sufficient plasticity that compaction or mechanical vibration is not required.

3.2 FIELD QUALITY CONTROL

A. General:

1. Make provisions for and furnish all material for the test specimens, and provide manual assistance to assist the Engineer in preparing said specimens.

2. Be responsible for the care of and providing curing condition for the test specimens.

B. Tests by Owner:

1. During the progress of construction, the Owner will have tests made to determine whether the controlled low strength material, as being produced, complies with the requirements specified hereinbefore. Test cylinders will be made and delivered to the laboratory by the Engineer and the testing expense will be borne by the Owner.

2. Test Cylinders:

a. Prepare test cylinders in accordance with ASTM C31 with the following exceptions:

1) Fill the concrete test cylinders to overflowing and tap sides lightly to settle the mix.

2) Do not rod the concrete mix.

3) Strike off the excess material.

b. Place the cylinders in a safe location away from the construction activities. Keep the cylinders moist by covering with wet burlap, or equivalent. Do not sprinkle water directly on the cylinders.

c. After 2 days, place the cylinders in a protective container for transport to the laboratory for testing. The concrete test cylinders are fragile and shall be handled carefully. The container may be a box with a Styrofoam or similar lining that will limit the jarring and bumping of the cylinders.

d. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.

e. Do not remove the test cylinder from mold until the cylinder is to be capped and tested.

f. The test cylinders may be capped with standard sulfur compound or neoprene pads:

1) Perform the capping carefully to prevent premature fractures.

2) Use neoprene pads a minimum of 1/2 inch thick, and 1/2 inch larger in diameter than the test cylinders.

3) Do not perform initial compression test until the cylinders reach a minimum age of 3 days.

3. Not less than 3 cylinder specimens will be tested for each 150 cubic yards of controlled low strength material and not less than 3 specimens for each half day's placement:

a. Test 1 cylinder at 3 days and 2 at 28 days in accordance with ASTM C39 except as modified herein.

b. The compression strength of the cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength.

4. The Owner will test the air content of the controlled low strength material. Test will be made immediately after discharge from the mixer in accordance with ASTM C231.

C. Tests by Contractor:

1. Test the slump of controlled low strength material using a slump cone in accordance with ASTM C143 with the following exceptions:

a. Do not rod the concrete material.

b. Place material in slump cone in one semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.

2. Test the slump at the beginning of each placement, as often as necessary to keep the slump within the specified range, and when requested to do so by the Engineer

END OF SECTION

SECTION 03480

PRECAST CATCH BASINS

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of furnishing and installing process equipment and other shown services, and also catch basins (drop inlets), all as shown on the drawings or specified herein.

1.02 SUBMITTALS

A. In accordance with Section 01300, submit manufacturer's literature and drawings showing complete layout, dimensions, design loadings, materials of construction, etc.

B. For all precast items which are manufactured, the Contractor shall also submit a list of the design criteria used by the manufacturer.

C. The Contractor shall submit approved ICBO reports for all lifting inserts, showing allowable design loads on the inserts.

D. Verification of compressive strength shall be submitted in accordance with Section 01300. Such verification may be laboratory trial batch test results with a minimum of three test cylinders or a series of production compression tests with a minimum of 20 sets of test data which fall within the evaluation and acceptance criteria specified herein. Such tests must have been made within the previous two years on the identical concrete mix submitted.

1.03 QUALITY ASSURANCE

Test methods and criteria for evaluation and acceptance of concrete shall be as specified in Section 03100, "Concrete".

1.04 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100: Concrete

B. Section 05530: Gratings, Stair Treads, and Floor Plates

C. Section 13217: Plastic Liner for Concrete Structures

PART 2: MATERIALS

2.01 VAULT AND CATCH BASIN DESIGN AND MANUFACTURE

A. Design Loads: Design loads shall consist of live load, dead load, impact load, hydrostatic load, and other loads that may occur. Live loads shall be for H-20 and/or H-20-S16-44, or as required, per AASHTO Standard Specifications for Highway Bridges with revisions. Design wheel loads shall be sixteen (16) kips.

Earth loads shall include a 2-foot soil surcharge.

B. Forms: All forms used in placing concrete shall be sufficiently designed and braced to maintain alignment under pressures of concrete placement.

C. Concrete: Class A

1. Aggregates used in the concrete mix either coarse or fine, excluding light-weight aggregates, shall conform to specifications as outlined by ASTM C33.

2. All light-weight aggregates, fine or coarse, shall conform to specifications as outlined by ASTM C330.

3. Both types of aggregates shall be properly graded and free of any deleterious substances so as to produce a homogeneous concrete mix when blended with cement.

D. Cement: The cement shall be Type II low alkali Portland cement and shall meet ASTM C150 Type II standards.

E. Compressive Strength: Sufficient cement content shall be used per batch so as to produce a minimum strength of 4,000 psi at 28 days or other strength by design when required.

F. Batching: A central batching facility shall be used to assure accurate weighing and mixing of materials to obtain a suitable concrete mix.

G. Placing: Concrete shall be made by properly proportioned parts of sand, aggregate and cement with sufficient water to produce a concrete mix of uniform quality and slump. Handling from the mixer or the transport vehicle to the forms for deposit will be in a continuous manner, as rapidly as practicable without segregation or loss of ingredients, until the unit or segment pouring is completed. Compaction by either external or internal mechanical vibration shall be used during the placement of the concrete mix.

H. Curing: Concrete while still in the forms may be steam cured after an initial set has taken place. Steam temperature shall not exceed 160°F, nor raised from normal ambient temperature at a rate exceeding 40°F per hour. Steam curing shall be considered complete after sufficient time has elapsed to produce adequate strength to withstand any structural strain that may be subjected during the form stripping operation. Additional curing may be applied by means of water spraying or membrane curing compound to reach the ultimate strength requirements.

I. Reinforcing Steel: All reinforcing steel, including welded wire mesh, shall be of the size and in the location required for design loads. All reinforcing shall be sufficiently tied to withstand any displacement during the pouring operation. All bars shall be intermediate grade, or as specified, billet steel conforming to ASTM A615 or ASTM 185 for welded wire fabric.

J. Preformed Joint Sealant: The joint sealing compound shall be Quik-Seal, a preformed, cold applied, ready to use plastic joint sealing compound as supplied by Quikset Utility Vaults, Santa Ana, California; Ram-Neck by K.T. Syder Company; or approved equal.

2.02 CATCH BASINS

A. Unless otherwise noted, catch basins shall be 3’ x 3’ x 6” wall thickness with bottom. Catch basins shall have progressive webbed knock-outs to provide maximum flexibility, permitting pipe of any size to be neatly and quickly grouted at the job site. All reinforcing steel shall meet ASTM specifications.

B. Catch Basin Grating: Cast iron or galvanized steel, H-20 traffic loading.

C. Manufacturers: Christy Concrete Products, Inc.; Jensen; or equal.

PART 3: EXECUTION

3.01 INSTALLATION

Catch basins shall be placed on 6-inch compacted class 2 aggregate base. Install level with top at grade in roadways and two to three inches above grade outside of roadways.

A. All exterior surfaces shall be coated with a minimum of 30 mil bituminous mastic.

3.02 CONNECTIONS

Connections to manufactured, precast items shall be made by casting sections of pipe into the items, using non-shrink grout as shown on the drawings, and/or using an approved resilient connector. All such connections shall be water tight.

END OF SECTION

SECTION 03700

CONCRETE SAW-CUTTING AND CORE-DRILLING

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of saw-cutting and/or core-drilling new openings in existing concrete structures.

1.02 RELATED WORK SPECIFIED ELSEWHERE

Section 03100: Concrete (Patching grout)

1.03 QUALITY ASSURANCE

Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

1.04 SUBMITTALS

A. Comply with pertinent provisions of Section 01300.

B. Submit sketches and commentary showing and describing the proposed cutting procedures for each type of cut.

PART 2: MATERIALS

2.01 Provide equipment in good and safe working order, adequate to perform the work.

2.02 Provide necessary scaffolding, lighting, access, debris removal equipment and devices, and appropriate safety measures.

PART 3: EXECUTION

3.01 SAFETY REGULATIONS

Comply with all applicable safety regulations including the requirements of "The Construction Safety Orders" of the State of California and the provisions of OSHA.

3.02 CONCRETE CUTTING

A. Perform concrete cutting as shown on the drawings and as specified herein and in accordance with the approved submittals.

B. Openings shall be cut to the dimensions shown on the drawings and shall not be

overcut. In straight-cut openings, the face opposite the saw shall be chipped to achieve the opening dimension.

3.03 PATCHING

A. Where existing reinforcing bars are cut at new opening, burn back the reinforcing bars a minimum of 1-inch below adjacent concrete.

B. Patch the resulting void at existing reinforcing bars and the surface of chipped opening surfaces with patching grout in accordance with Section 03100: Concrete, to achieve a smooth, uniform surface.

3.04 DISPOSAL

A. Remove cut material and dispose of off-site in a safe and orderly manner. Do not allow debris to accumulate on the site exposed to view.

B. Inside structures, cuttings, chippings and patching grout droppings must be removed completely. No debris shall be washed into the plant's drain system.

C. Upon completion of the work of this section, the surfaces of all structures shall be clean and free of cuttings, slurry and debris.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of providing miscellaneous metal work shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 09900: Painting

1.03 GOVERNING COVER AND STANDARDS

A. The Aluminum Association “Specifications and Guidelines for Aluminum Structures”

1.04 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

B. Perform shop and/or field welding required in connection with the work of this section in strict accordance with pertinent recommendations of the American Welding Society.

1.05 SUBMITTALS

A. Comply with pertinent provisions of Section 01300.

B. Product data to be submitted:

1. Materials list of items proposed to be provided under this Section;

2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;

3. Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades;

4. Manufacturer's recommended installation procedures which, when approved by the Engineer, will become the basis for accepting or rejecting

actual installation procedures used on the work.

PART 2: MATERIALS

2.01 MATERIALS

A. In fabricating items which will be exposed to view, limit materials to those which are free from surface blemishes, pitting, rolled trade names, and roughness.

B. Unless noted otherwise, comply with the following standards, as pertinent.

1. Steel plates, shapes, and bars: ASTM A36.

2. Steel plates to be bent or cold-formed: ASTM A283, grade C.

3. Steel tubing (hot-formed, welded, or seamless): ASTM A501.

4. Steel bars and bar-size shapes: ASTM A306, grade 65, or ASTM A36.

5. Cold-finished steel bars: ASTM A108.

6. Cold-rolled carbon steel sheets: ASTM A336.

7. Galvanized carbon steel sheets: ASTM A526, with G90 zinc coating in accordance with ASTM A525.

8. Stainless steel bars, plates, structural shapes, ASTM A276, Type 304.

9. Stainless steel sheets: AISI type 302 or 304, 24 gauge, with Number 4 finish.

10. Aluminum plates, shapes, and bars, 6061-T6 or 6063-T6 alloy, mill finish unless otherwise specified.

11. Grey iron castings: ASTM A48, Class 40.

12. Malleable iron castings: ASTM A47.

13. Steel pipe: ASTM A120, schedule 40, black finish unless otherwise noted.

14. Concrete inserts:

a. Threaded or wedge type galvanized ferrous castings of malleable iron complying with ASTM A27.

b. Provide required bolts, shims, and washers, hot-dip galvanized in accordance with ASTM A153.

2.02 FABRICATION

A. Except as otherwise shown on the Drawings or the approved Shop Drawings, use materials of size, thickness, and type in accordance with this Section.

B. Fabricate with accurate angles and surfaces which are true to the required lines and levels, grinding exposed welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.

C. Prior to shop painting or priming, properly clean metal surfaces as required for the applied finish and for the proposed use of the item.

D. On surfaces inaccessible after assembly or erection, apply two coats of the specified primer. Change color of second coat to distinguish it from the first.

E. Properly mark and match-mark materials for field assembly and for identification as to location for which intended.

F. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.

G. Where finishing is required, complete the assembly, including welding of units, before start of finishing operations.

H. Provide finish surfaces of members exposed in the final structure free from markings, burrs, and other defects.

2.03 CASTINGS

A. All castings shall be sound and free from shrinkage crack, blow holes, and other defects. All fins and burnt sand must be removed. Excessive porosity and spongy surfaces will constitute causes for rejection. The Engineer shall be final judge as to whether the defects present are sufficient to cause rejection.

B. No welding or patching of defects in castings will be permitted unless authorized by the Engineer. Any such welding or patching done without the Engineer's consent shall be cause for rejection.

C. All castings shall be true to form and dimensions shown on the Drawings. After inspection and prior to shipping, all machined surfaces shall be coated with a blue rust inhibitive lacquer, or other approved material which can be easily removed, unless otherwise specified.

D. The dimensions of the finished castings shall not be less than the specified dimensions. Castings shall not be more than seven and one-half (7-1/2) percent overweight. Large castings shall be suspended and hammered over their entire area. No cracks, flaws, or other defects shall appear after such hammering.

E. Castings shall be provided with adequate continuous fillets cast in place in all re-entrant angles. The radius of curvature of the exposed surface of a fillet shall define the size of the fillet. The size of fillets shall not be less than one-half (1/2) of the thickness of the thinnest adjoined member nor less than one-half (1/2) inch.

F. Iron castings shall be dipped or painted with asphalt which will form a tough, tenacious, non-scaling coating which does not have a tendency to become brittle when cold or sticky when hot.

G. The covers and seats shall be machined so that the cover sits evenly and firmly in the frame.

2.04 CONNECTIONS

A. Provide bolts and washers of types and sizes required for completion of field erection.

B. Welded Construction: Comply with AWS Code for procedures, appearance, and quality of welds, and methods used in correcting welded work.

C. Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.

2.05 FASTENERS

A. General

1. For exterior use and where built into exterior walls, provide zinc-coated fasteners.

2. Provide fasteners of type, grade, and class required for the particular use.

B. Stainless steel fasteners: For wet or submerged service, all bolts, nuts, and flat washers, Type 316 stainless steel, ASTM F593 and F594, Group 2.

C. Wedge Anchors (WA): Type 303 or 304 stainless steel red head Phillips wedge anchors, as shown, manufactured by ITT Phillips Drill Division, Michigan City, Indiana 46460, U.S.E. Diamond, Inc., York, PA 17405, or equal.

D. Expansion Anchors (EA): Type 303 or 304 stainless steel Red Head multi-set anchors as manufactured by ITT Phillips Drill Div., U.S.E. Diamond, Inc., or equal.

E. Adhesive Anchors: Type 303 or 304 stainless steel with Hilti HIT C100 system or equal.

F. Stud Anchors: Shall be H4L mild steel concrete anchors, as manufactured by TRW

Inc., Nelson Division, Lorain, Ohio 44055, or equal. Stud anchors shall be of a design suitable for arc welding to steel with automatically timed stud welding equipment.

G. Comply with the following standards as pertinent:

1. Bolts and Nuts: Provide hexagon-head regular type complying with ASTM A307, Grade A (Steel); ASTM A320 and A194, Grade B8 (Stainless Steel).

2. Lag bolts: Provide square-head type complying with Fed. Spec. FF-B-561.

3. Machine Screws: Provide cadmium plated steel type complying with Fed. Spec. FF-S-111; except use stainless steel for damp locations or with aluminum.

4. Washers

a. Plain washers: Comply with Fed Spec FF-W-92, round, carbon steel.

b. Lock washers: Comply with Fed. Spec FF-W-84, helical spring type carbon steel.

5. Toggle bolts: Provide type, class, and style needed but complying with Fed. Spec. FF-B-588.

6. Anchorage devices: Provide expansion shield complying with Fed Spec FF-S-325.

2.06 HOLES FOR OTHER WORK

A. Provide holes required for securing other work to metalwork and for passage of other work as shown on the approved Shop Drawings.

B. Provide threaded nuts welded to framing, and other specialty items as shown, to receive other work.

C. Cut, drill, or punch holes perpendicular to metal surfaces.

D. Do not flame cut holes or enlarge holes by burning.

E. Drill holes in bearing plates.

2.07 ANCHORING DEVICES

1. Cast-in-Place Anchor Bolts

a. Bolt: Conform to ASTM A320 stainless steel

b. Minimum Length of Bolt: Per design calculations or per Drawings

c. Head Type: Hexagonal headed bolt

d. Nuts and washers: ASTM A194 stainless steel

2. Concrete Anchors

a. Drilled in place wedge-type anchors with integral threaded studs.

b. Manufacturers: One of the following or equal:

1) ITW Ramset/Redhead, Trubolt Wedge.

2) Hilti Kwikbolt TZ.

3. Studs

a. ASTM A108 with 50,000 pounds per square inch minimum yield strength, and 60,000 pounds per square inch minimum tensile strength.

b. Manufacturers: One of the following or equal:

1) Nelson Stud Welding Company, S3L Shear Connectors or H4L Concrete Anchors.

2) Stud Welding Products, Headed Concrete Anchors and Shear Connectors or Concrete Anchors.

4. Chemical Anchors

a. Do not use in overhead applications, in chlorine gas environments, or where anchor may be exposed to machine or diesel oils.

b. Materials: Type 303 or 304 stainless steel all-thread rod with vinyl ester resin adhesive.

1) Stainless steel all-thread rod: Conform with ASTM F593.

c. Manufacturers: One of the following or equal:

1) Hilti RE 500-SD System, ITW Redhead Epcon G5, or equal.

2.08 OTHER MATERIALS

Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

2.09 GALVANIZING

A. Shall be double hot-dip processed after fabrication, ASTM A123, A153, A386, and A525. Double dip shall be required, if necessary, to achieve required coating weight.

B. For repair of galvanizing, use galvaloy stick applied as recommended by the manufacturer.

2.10 SHOP PRIMING

A. General

1. Shop prime un-galvanized steel work, except those members or portions of members to be embedded in concrete or mortar.

2. Paint embedded steel which is partially exposed on the exposed portions, and the initial 2" of embedded areas only.

B. Surface Preparation

1. After inspection and before shipping, clean steelwork to be painted.

2. Remove loose rust, loose mill scale, and spatter, slag, and flux deposits.

3. Prepare steel in accordance Section 09900. If not specified, prepare steel in accordance with Steel Structures Painting Council SP-3, "Power Tool Cleaning."

C. Primer Painting

1. Immediately after surface preparation, apply structural steel primer paint in accordance with Section 09900 and the manufacturer's recommendations and at a rate to provide a uniform dry film thickness.

2. Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.

3. The Contractor shall be responsible for providing the required coating system per Section 09900. The Contractor shall remove shop coatings not in conformance with Section 09900. Additionally, the Contractor shall prepare any shop applied coating, which, while meeting the requirements of

Section 09900, requires additional surface preparation in order to obtain a mechanical bond between coatings.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 COORDINATION

Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

3.03 INSTALLATION

A. General

1. Set work accurately into position, plumb, level, true, and free from rack.

2. Anchor firmly into position.

3. Where field welding is required, comply with AWS recommended procedures of manual-shielded metal-arc-welding for appearance and quality of weld and for methods to be used in correcting welding work.

4. Grind exposed welds smooth, and touch-up shop prime coats.

5. Do not cut, weld, or abrade surfaces which have been hot-dip galvanized after fabrication and which are intended for bolted or screwed field connections.

6. Dissimilar Materials: Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint conforming to MIL-C-18480 or to TT-V-51 or a coat of zinc chromate primer conforming to TT-P-645 to prevent galvanic or corrosive action.

7. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. All bolts, anchors, supports, braces, connection and other items necessary for completion of the miscellaneous metalwork shall be provided.

B. Anchor Bolts: Provide anchor bolts or wedge anchors as a minimum unless

otherwise shown on the drawings.

C. Immediately after erection, clean the field welds, bolted connections, and abraded areas of shop priming. Paint the exposed areas with same material used for shop priming.

D. CAST-IN-PLACE ANCHOR BOLTS

1. Accurately place anchor bolts to be embedded in concrete within the formwork and perpendicular to surface from which they will project. Secure in correct position while concrete is placed.

2. Do not allow anchor bolts to touch reinforcing steel.

   a) Where anchor bolts are within 1/4 inch of reinforcing steel, isolate with a minimum of 4 wraps of 10 mil polyvinyl chloride tape in area adjacent to reinforcing steel.

3. In anchoring machinery bases subject to heavy vibration, use 2 nuts, with 1 serving as a locknut.

4. Where bolts are indicated on the Drawings for future use, first coat thoroughly with non-oxidizing wax, then turn nuts down full depth of thread and neatly wrap exposed thread with waterproof polyvinyl tape.

5. Where indicated on the Drawings, set anchor bolts in metal sleeves having inside diameter approximately 2 inches greater than the bolt diameter and a minimum of 10 bolt diameters deep.

6. Fill sleeves with grout when equipment is grouted in place.

7. Anchor bolts may be cast in concrete in lieu of using concrete anchors.

E. CONCRETE ANCHORS AND CHEMICAL ANCHORS

1. Do not use concrete anchors or chemical anchors in lieu of anchor bolts.

2. Drill holes using concrete drill bits and impact type drill motors.

3. Hole diameter: in accordance with the manufacturer’s recommendations.

4. Clean drilled hole using compressed air to dislodge and remove drilling dust.

5. Accurately locate concrete anchors and set perpendicular to surfaces from which they will project.

6. Minimum embedment lengths shall be per manufacturer safe load tables.

END OF SECTION

SECTION 05501

ANCHOR BOLTS AND ANCHORING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Anchor bolts, concrete anchors and other anchoring devices for mechanical and electrical equipment.

1.02 REFERENCED SECTIONS

A. The following Sections are referenced in this Section

1. Section 01300 - Submittals

1.03 DESIGN REQUIREMENTS

A. Comply with the current edition of the California Building Code (CBC).

B. Where specified in the individual equipment sections or in the specifications, provide structural calculations and supporting drawings including details stamped and signed by a professional civil or structural engineer registered in the State of California. Submit with equipment submittal.

1.04 SUBMITTALS

A. Comply with Section 01330.

B. Include the following items:

1. Product Data: Manufacturer’s data for nuts, bolts, concrete anchors, chemical anchors and other fasteners.

2. Catalog data and ICC-ES reports for each type of anchor bolt.

1.05 QUALITY ASSURANCE

A. Provide special inspection for the installation of chemical anchors in accordance with CBC and Section 01455.

B. Do not use expansion-type concrete anchors or adhesive-type anchors set in holes drilled in the concrete as a substitution for cast-in-place anchor bolts.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified or indicated on the Drawings, materials of construction for anchoring devices shall conform to the following:

1. Anchor bolts and other anchoring devices, nuts and washers installed indoors: Type 304 stainless steel.

2. Anchor bolts and other anchoring devices, nuts and washers installed outdoors or in locations exposed to wastewater: Type 316 stainless steel.

a. Locations exposed to wastewater includes:

1) Below tops of walls of water-containing structures.

2) Underside of roof, slab or walkways of enclosed water-containing structures.

3) Dry side of walls on water-containing structures.

2.02 ANCHORING DEVICES

A. Cast-in-Place Anchor Bolts

1. Bolt: Conform to ASTM A320 stainless steel

2. Minimum Length of Bolt: Per design calculations or per Drawings

3. Head Type: Hexagonal headed bolt

4. Nuts and washers: ASTM A194 stainless steel

B. Concrete Anchors

1. Drilled in place wedge-type anchors with integral threaded studs.

2. Manufacturers: One of the following or equal:

a. ITW Ramset/Redhead, Trubolt Wedge.

b. Hilti Kwikbolt TZ.

3. Materials: Type 303 or 304 stainless.

C. Studs

1. ASTM A108 with 50,000 pounds per square inch minimum yield strength, and 60,000 pounds per square inch minimum tensile strength.

2. Manufacturers: One of the following or equal:

   a. Nelson Stud Welding Company, S3L Shear Connectors or H4L Concrete Anchors.

   b. Stud Welding Products, Headed Concrete Anchors and Shear Connectors or Concrete Anchors.

D. Chemical Anchors

1. Do not use in overhead applications, in chlorine gas environments, or where anchor may be exposed to machine or diesel oils.

2. Materials: Type 303 or 304 stainless steel all-thread rod with vinyl ester resin adhesive.

   a. Stainless steel all-thread rod: Conform with ASTM F593.

3. Manufacturers: One of the following or equal:

   a. Hilti RE 500-SD System, ITW Redhead Epcon G5, or equal.

PART 3 - EXECUTION

3.01 GENERAL ANCHORING REQUIREMENTS

A. Install anchor bolts, concrete anchors and other anchoring devices with at least 2 threads projecting beyond the nut, but no more than 1/2-inch projecting beyond the nut.

B. Prior to installing nuts, coat threads of stainless steel bolts with material to prevent galling of threads.

1. Manufacturers: One of the following or equal:

   a. Never Seez Compound Corporation, Never-Seez.

   b. Oil Research, Inc., WLR No. 111.

C. Tighten nuts on anchor bolts, concrete anchors and other anchoring devices to the "snug-tight" condition, defined as tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary wrench.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Accurately place anchor bolts to be embedded in concrete within the formwork and perpendicular to surface from which they will project. Secure in correct position while concrete is placed.

B. Do not allow anchor bolts to touch reinforcing steel.

1. Where anchor bolts are within 1/4 inch of reinforcing steel, isolate with a minimum of 4 wraps of 10 mil polyvinyl chloride tape in area adjacent to reinforcing steel.

C. In anchoring machinery bases subject to heavy vibration, use 2 nuts, with 1 serving as a locknut.

D. Where bolts are indicated on the Drawings for future use, first coat thoroughly with non-oxidizing wax, then turn nuts down full depth of thread and neatly wrap exposed thread with waterproof polyvinyl tape.

E. Where indicated on the Drawings, set anchor bolts in metal sleeves having inside diameter approximately 2 inches greater than the bolt diameter and a minimum of 10 bolt diameters deep.

F. Fill sleeves with grout when equipment is grouted in place.

G. Anchor bolts may be cast in concrete in lieu of using concrete anchors.

3.03 CONCRETE ANCHORS AND CHEMICAL ANCHORS

A. Do not use concrete anchors or chemical anchors in lieu of anchor bolts.

B. Drill holes using concrete drill bits and impact type drill motors.

C. Hole diameter: in accordance with the manufacturer’s recommendations.

D. Clean drilled hole using compressed air to dislodge and remove drilling dust.

E. Accurately locate concrete anchors and set perpendicular to surfaces from which they will project.

F. Minimum embedment lengths shall be per manufacturer safe load tables.

END OF SECTION

SECTION 07920

CAULKING AND SEALANTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. The purpose of caulking in this work is to provide a positive barrier against the penetration of air and moisture at joints between items where caulking is essential to the continued integrity of the barrier or to finish construction.

2. Such caulking will normally be performed under the work of various sections of these specifications but shall be performed in strict accordance with the provisions of this section.

3. All sealants shall be installed prior to application of paints and waterproof coatings.

4. All caulking, sealants and adhesives shall comply with Pollutant Control and VOC Limits per SCAQMD Rule 1168 and CGBSC Table 5.504.4.1 and Table 5.504.4.2

B. Related work described elsewhere: Caulking in this work may be required in the execution of work of the various sections of these specifications.

1.02 REFERENCES

A. SWRI (Sealant, Waterproofing and Restoration Institute) – Sealant and Caulking Guide Specifications.

B. ASTM C1193 –Standard Guide Sealants

C. ASTM C834 – Latex Sealing Compounds.

D. ASTM C919 – Use of Sealants in Acoustical Applications.

E. ASTM C920 – Elastomeric Joint Sealants.

F. ASTM D1056 – Flexible Cellular Materials - Sponge or Expanded Rubber.

1.03 SUBMITTALS

A. Comply with Section 01300 – Submittals.

B. MSDS Data Sheet.

C. Samples:

1. Samples of all exposed caulking and sealants are required for Engineer's approval. Unless directed otherwise, apply samples in six-inch runs in actual joints at the job site. The samples shall show the materials, workmanship, bond, and color of the caulking work throughout the project and shall match that of the approved sample joint.

2. Samples: Submit two samples illustrating sealant colors for selection.

D. Product Data: Provide manufacturer's data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

1.04 QUALITY ASSURANCE

A. Qualifications of Applicators:

1. Company specializing in performing the work of this section with five (5) years' minimum documented experience approved by manufacturer.

2. Installation of caulking shall be performed only by workmen thoroughly skilled and specially trained in the techniques to apply caulking, and who are completely familiar with the written recommendations of the manufacturer of the caulking material used.

3. Indication of lack of skill on the part of caulking installers shall be sufficient grounds for the Engineer to reject installed caulking and to require its immediate removal and complete re-caulking at no additional cost to the Owner.

B. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five (5) years' documented experience.

C. Inspection Prior to Installation: Applicator and/or sealant representative must provide a written statement prior to installation of the sealant that the areas to be sealed are acceptable. All corrections should be done before those areas are sealed.

D. Perform work in accordance with SWRI requirements and as modified by sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

E. Perform acoustical sealant application work in accordance with ASTM C 919.

F. Maintain one (1) copy of each document on site.

1.05 PRODUCT HANDLING

A. Storage

1. Store all caulking materials and equipment under conditions recommended by its manufacturer.

2. Do not use materials stored for a period of time exceeding the maximum recommended shelf life of the material.

B. Protection: Use all means necessary to protect caulking materials before, during and after installation and to protect the installed work and materials of other trades.

C. Handling: Comply with manufacturer's recommendations for proper handling and protection of sealant material.

D. Repairs: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

1.06 COORDINATION

A. Coordinate the work with all sections referencing this section.

1.07 JOB CONDITIONS

A. Schedule operations so that working joints are most likely to be normal size. Apply materials within manufacturer recommended surfaces and ambient temperature ranges.

1.08 WARRANTY

A. Include coverage for installed sealants accessories which fail to achieve airtight seal; watertight seal, and exhibit loss of adhesion or cohesion, or do not cure.

B. Materials –Ten (10) years vertical, five (5) years horizontal.

C. Installation – Two (2) years.

PART 2 – PRODUCTS

2.01 MATERIALS

A. All materials, unless otherwise specifically approved by the Engineer, shall be single or plural component, compatible with substrates, non-sagging or self-leveling, and non-staining type in neutral color, color per drawings or other color approved by the Engineer where exposed to view.

2.02 SEALANTS

One of the following, or an equal approved by the Engineer from manufacturer's standard colors, unless otherwise specified for this project:

A. Silicone:

1. One part, conforming to ASTM C-920-87, Type S, Grade NS, Class 25 for construction joints, Chem-Calk1200 Bostik, Inc., Pecora 860, Pecora Corp., Dow Corning #795, General Electric Silpruf #2000 or equal.

2. One part conforming to ASTM C-920-87, Type S, Grade NS, Class 25, for glazing details, Chem-Calk1200 Bostik, Inc., Pecora 860, Pecora Corp Dow Corning #999, General Electric #4000 or #2000 or equal.

B. Polyurethane:

1. One part, gun-grade sealant conforming to ASTM C920-87 Type s, Grade NS, Uses: expansion and control joints in metal curtain wall, perimeter of door and window framing; Chem-Calk 900 series by Bostik, Inc., Dyna Trol I-XL by Pecora Corp. Sika-Flex 1-A or15 L-M, or equal

2. Two part, gun-grade sealant conforming to ASTI 920 87 Type M, Grade M, Sika-Flex 2C-NS or equal.

3. Two part, self-leveling sealant conforming to ASTM C-920-87 type M, Grade P, 2C or equal. For Hard Traffic use: Chem-Calk 555-SL, Sika-Flex 7G.

C. Interior Sealant: Acrylic Latex, one part, gun-grade, paintable conforming to ASTM C-834-81, Chem-Calk 600 series or Pecora AC-20 plus silicone or equal.

D. Acoustical Sealant: For concealed joints to control sound transmission dust and air. Henry's #313 or equal.

E. Backer Rod: All filler material shall be new and clean with no oils and non-staining. Also, all filler material shall be made of polyethylene foam, completely compatible with the caulking material and as recommended by the caulking manufacturer for the materials, joint conditions and use.

2.03 EQUIPMENT

A. All equipment shall be only such equipment as is specifically recommended by the manufacturer of the caulking material being installed.

2.04 MIXING

A. Follow manufacturer's mixing instructions for mixing ratios, temperature limitations and length of mixing times.

PART 3 – EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection:

1. Prior to all caulking, carefully inspect the surfaces to which caulking is to be applied and verify that they are clean, sound, and free from deleterious material which might adversely affect the bond.

2. Verify that caulking may be installed in accordance with the manufacturer's recommendations.

B. Corrections:

1. Clean all surfaces as necessary.

2. In the event of discrepancy, immediately notify the Engineer.

3. Do not proceed with installation of caulking in areas of discrepancy until all such discrepancies have been resolved.

3.02 CHOICE OF CAULKING MATERIAL

A. Use only that caulking material which is best suited to the installation and is so recommended by the caulking material manufacturer.

3.03 PREPARATION AND INSTALLATION

A. Joint Design: Size of joint shall be calculated to allow for anticipated movement to be within the capabilities of the approved sealant. Unless otherwise required by sealant manufacturer's printed recommendations, use backing material to control sealant depths as follows:

1. Minimum Width: Not less than ¼-inch wide.

2. Minimum Depth: Not less than ¼-inch deep.

3. Maximum Movement: The width of the joint shall be wide enough to allow the sealant to work within its limitations.

4. Width/Depth Ratio: The depth of the sealant should be no greater than the width. As a general rule, the width should be twice the depth. If joint width is over ½ inch, caulking shall remain ½ inch thick across joint.

B. Joint Cleaning: Clean all joints thoroughly and blow out or vacuum loose particles from joints. Material in contact with sealant shall be dry, fully cured, and free of laitance, loose aggregate, form release agents, curing compounds, water repellants, paint, and other surface treatments. Surfaces with protective coatings shall be cleaned to remove protective coatings or oil deposits. Joints in masonry and concrete work shall not be sealed until substrate has cured a minimum of 12 days.

C. Primers: Primer shall be provided on metal, masonry, concrete, and wood surfaces, and other surfaces as recommended by the sealant manufacturer. Primer shall not be applied to surfaces which will be exposed after caulking is completed.

D. Joint Backing: Backing shall be installed in all joints to receive sealant. Backing shall be sized to require 20-percent to 50-percent compression upon insertion and placed in accordance with the "Joint Design" paragraph. In joints not of sufficient depth to allow backing, install bond breaking tape at back of joint. Avoid lengthwise stretching of backing material.

1. Backing material shall be a resilient type such as Soft-Backer Rod closed cell backer rod, as recommended by the manufacturer. Oakum or other types of absorptive materials shall not be used as a backing material. When closed cell backing is used, care must be exercised to avoid puncturing of the skin opening up the cell structure.

2. Install closed cell rod 24 hours prior to application of sealant to allow outgassing of rod.

3.04 APPLICATION

A. Apply sealant immediately after joints are cleaned, primed and backed. Work in vertical surfaces shall be done with standard hand-caulking guns or power actuated caulking guns. The sealant shall be extruded through nozzles of such diameter as to allow a full bead of materials to run into joint, and not to exceed width of joint. Force sealant into joint by tooling to ensure full contact with side-walls and backing.

3.05 JOINT FINISHING

A. Neatly tool joints to slightly concave surface using methods recommended by sealant manufacturers. Repair any air pockets exposed by tooling. Tool so as to compress material and improve adhesion to surface joints. At horizontal traffic joints, tool joints 1/8 inch below finish grades. At horizontal building flashing joints, tool material to divert water away from joint or to prevent the ability to collect water.

3.06 CLEAN UP

A. All surfaces adjacent to the sealant shall be cleaned of all excess sealant or primer and left in neat condition subject to the approval of the Engineer.

3.07 SCHEDULE

A. Polyurethane: Concrete, aluminum, wood, door and window frames, exterior trim.

B. Silicone: Glass to Glass, Glass to Aluminum, Solid Surfacing, Plastics and Metals, other as approved by material manufacture and Engineer.

C. Acrylic Latex: Interior Use Only. Paint, Gypsum Drywall, trim, etc.

END OF SECTION

Section 08310

ACCESS HATCHES

PART 1: GENERAL

1.01 SUMMARY

Section includes furnishing and installing access hatches.

1.02 SUBMITTALS

A. In accordance with Section 01300, submit product data.

B. Shop Drawings

1. Show profiles, accessories, and dimensions.

2. Show locations of access doors.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Identify type and size of each door in way not to damage finish prior to delivery.

B. Deliver products only after proper facilities are available.

C. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of use.

D. Handle carefully to prevent damage and store on clean concrete surface or raised platform in safe, dry area. Do not dump onto ground.

E. Protect access doors during shipment and storage to prevent warping, bending, and corrosion.

1.04 QUALITY ASSURANCE

A. All hatches located over submersible pumps with guide rails shall be supplied by the same manufacturer as the submersible pump.

B. All hatches not located over a submersible pump shall be supplied by the same manufacturer and as specified herein.

PART 2: PRODUCTS

2.01 FLOOR ACCESS HATCH (H-20 LOADING)

A. Manufacturers

One of the following or equal:

1. The Bilco Co., Type JD-AL-H20 or JAL-H20.
2. Babcock-Davis Associates, Inc.
3. US Foundry
4. Syracuse Castings
5. Halliday Products

B. Style: Single or double leaf, aluminum, capable of withstanding H20 loading, channel frame, with drainage couplings. Hatches with openings greater than 36-inches in the long dimension shall be double leaf type.

C. Door Leaf: Minimum ¼ -inch aluminum diamond pattern plate.

D. Frame: ¼ -inch extended aluminum channel with bend down anchor tabs around perimeter. A continuous EPDM gasket shall be mechanically attached to the frame.

E. Hardware:

1. Hinges: Equipped with heavy forged aluminum hinges with 1/4-inch diameter stainless steel pins.
2. Lock: Snap lock with removable handle mounted on door leaf.
3. Grip Handle: Provide vinyl grip handle designed to release cover for closing.
4. Operating Mechanism: Compression spring tubes designed for ease of operation and automatic hold-open arm with release handle.
5. Provide 1 ½ -inch drainage coupling located in front right corner of channel frame where drainage is not allowed within structure.
6. Provide fall protection hooks and netting for all hatches.

F. Minimum access hatch size and style are shown on the drawings.

2.02 FLOOR ACCESS HATCH (300 PSF LOADING)

A. Manufacturers

One of the following or equal:

1. The Bilco Co., Type JD-AL or J-AL.
2. Babcock-Davis Associates, Inc., Model GT.

3. US Foundry

B. Style: Single or double leaf, aluminum, capable of withstanding minimum live load of 300 pounds per square foot, channel frame, with drainage couplings.

C. Door Leaf: Minimum ¼ -inch aluminum diamond pattern plate capable of withstanding a live load of 300 pounds per square foot.

D. Frame: ¼ -inch aluminum channel with bend down anchor tabs around perimeter. A continuous EPDM gasket shall be mechanically attached to the aluminum frame.

E. Hardware

1. Hinges: Equipped with a minimum of two heavy forged aluminum hinges with stainless steel pins.

2. Lock: Snap lock with removable handle mounted on door leaf.

3. Grip Handle: Provide vinyl grip handle designed to release cover for closing.

4. Operating Mechanism: Spring operators designed for ease of operation and automatic hold-open arm with release handle.

5. Provide 1 ½ -inch drainage coupling located in front right corner of channel frame where drainage is not allowed within structure.

F. Access hatch size and style are shown on the drawings.

2.03 WARRANTY

Hatch manufacturer shall provide 25 year warranty against defects in materials and workmanship.

2.04 FINISHES

Floor Access Door Types

A. Aluminum: Manufacturer's standard mill finish.

B. Aluminum in contact with dissimilar metals and concrete: Manufacturers standard bituminous coating.

C. All hardware shall be 316 stainless steel.

PART 3: EXECUTION

3.01 EXAMINATION

Examine construction to receive access door and verify correctness of dimensions and other supporting or adjoining conditions.

3.02 PREPARATION

A. Coordinate details with other work supporting, adjoining, or requiring access doors.

B. Verify dimensions, profiles, and fire-resistive rating for each opening.

C. Verify that location will serve portion of work to which access is required. Where proposed functional location conflicts with other work, notify the Engineer before installation.

D. Apply bituminous coating to aluminum surfaces that will be in contact with dissimilar metals or concrete.

3.03 INSTALLATION

A. Install access doors in accordance with manufacturer's instructions.

B. Ensure correct types and adequate sizes at proper locations.

C. Securely attach frames to supporting work and ensure doors, frames, and hardware operate smoothly and are free from warp, twist, and distortion.

D. Coat all aluminum in contact with concrete.

3.04 ADJUSTING

Adjust doors, frames, and hardware to operate smoothly, freely, and properly, without binding.

3.05 CLEANING

Thoroughly clean surfaces of grease, oil, or other impurities, touch-up abraded prime coat.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 – GENERAL

1.07 SUMMARY

A. SECTION INCLUDES

1. The work in this Section includes furnishing all items of finish hardware as hereinafter specified or necessary, for all swinging doors.

B. RELATED SECTIONS

1. Section 08110 –Steel Doors and Frames
2. Section 01300 – Submittals

1.08 REFERENCES

A. STANDARDS

1. ANSI-A250.4 – Steel Doors and Frames Physical Endurance
2. ANSI A156.1 – Butts and Hinges
3. ANSI A156.3 – Exit Devices
4. ANSI A156.4 – Door Controls – Door Closers
5. ANSI A156.5 – Auxiliary Locks and Associated Products
6. ANSI A156.6 – Architectural Door Trim
7. ANSI A156.7 – Template Hinge Dimensions
8. ANSI A156.8 – Door Controls – Overhead Holders
9. ANSI A156.13 – Mortise Locks and Latches
10. ANSI A156.16 – Auxiliary Hardware
11. ANSI A156.18 – Material and Finishes
12. ANSI A156.26 – Continuous Hinges

B. CODES

1. NFPA 101 – Life Safety Code

2. CBC 2013 – California Building Code

3. ANSI A117.1 – Accessible and Usable Buildings and Facilities

4. ADA – Americans with Disabilities Act

1.09 SUBMITTALS

A. Comply with Section 01300 – Submittals.

B. GENERAL REQUIREMENTS

1. Submit copies of finish hardware schedule in accordance with Section 01300 – Submittals.

C. SCHEDULES AND PRODUCT DATA

1. Schedules to be in vertical format, listing each door opening, and organized into "hardware sets" indicating complete designations of every item required for each door opening to function as intended. Note any special mounting instructions or requirements with the hardware schedule. Schedules to include the following information:

a. Location of each hardware set cross-referenced to indications on drawings, both on floor plans and in door and frame schedule.

b. Handing and degree of swing of each door.

c. Door and frame sizes and materials.

d. Keying information.

e. Type, style, function, size, and finish of each hardware item.

f. Name and manufacturer of each hardware item.

g. Fastenings and other pertinent information.

h. Explanation of all abbreviations, symbols and codes contained in schedule

i. Mounting locations for hardware when varies from standard.

2. Submit catalog cuts and/or product data sheets for all scheduled finish hardware.

D. OPERATIONS AND MAINTENANCE MANUALS

1. Upon completion of construction and building turnover, submit maintenance manuals per Section 01300. Manuals to include the following items at a minimum:

   a. Approved hardware schedule, catalog cuts and keying schedule.

   b. Hardware installation and adjustment instructions.

   c. Manufacturer's written warranty information.

1.10 QUALITY ASSURANCE

A. SUPPLIER QUALIFICATIONS

1. A recognized architectural door hardware supplier who has maintained an office and has been furnishing hardware in the project's vicinity for a period of at least two (2) years.

2. Hardware supplier shall have office and warehouse facilities to accommodate this project.

3. Hardware supplier shall have in his employment at least one (1) Architectural Hardware Consultant (AHC) who is available at reasonable times during business hours for consultation about the project's hardware and requirements to the Owner, Engineer and Contractor.

4. Hardware supplier must be an authorized factory distributor of all products specified herein.

1.11 FIRE-RATED OPENINGS

1. Provide door hardware for fire-rated openings that comply with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed by Underwriter's Laboratories (UL) or Warnock Hersey (WH) for use on types and sizes of doors indicated.

2. Project requires door assemblies and components that are compliant with positive pressure and S-label requirements. Specifications must be cross-referenced and coordinated with door manufacturers to ensure that total opening engineering is

compatible with UL10C Standard for Positive Pressure Fire Tests of Door Assemblies.

a. Hardware required for fire doors shall be listed with Underwriters Laboratories for ratings specified.

b. Certification(s) of compliance shall be made available upon request by the Authority Having Jurisdiction.

1.12 DELIVERY, STORAGE AND HANDLING

A. MARKING AND PACKAGING

1. Properly package and mark items according to the approved hardware schedule, complete with necessary screws, accessories, instructions and installation templates for spotting mortising tools. Check deliveries against accepted list and provide receipt for them, after which he is responsible for storage and care. Any shortage or damaged goods shall be provided or replaced without cost to the Owner.

2. Packaging of door hardware is the responsibility of the supplier. As hardware supplier receives material from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set and door numbers to match the approved hardware schedule. Two or more identical sets may be packed in same container.

B. DELIVERY

1. The supplier shall deliver all hardware to the project site; direct factory shipments are not allowed. Hardware supplier shall coordinate delivery times and schedules with the Contractor. Inventory door hardware jointly with representatives of hardware supplier and hardware installer/contractor until each is satisfied that count is correct.

2. No keys are to be packed in boxes with the locks.

3. At time of hardware delivery, the Contractor, in conjunction with the supplier, shall check in all hardware and set up a hardware storage room.

C. STORAGE

1. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not

immediately replaceable so that completion of work will not be delayed by hardware losses both before and after installation.

1.13 WARRANTY

A. All items, except as noted below, shall be warranted in writing by the manufacturer against failure due to defective materials and workmanship for a minimum period of one (1) year commencing on the date of final completion and acceptance. In the event of product failure, promptly repair or replace item with no additional cost to the Owner.

1. Mortise locksets: Seven (7) years

2. Exit Devices: Five (5) years

3. Door closers: Ten (10) years

4. Securitron (and approved equals) electrified hardware: Unlimited Lifetime

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers as listed below shall be accepted. Obtain each type of finish hardware (hinges, latch and locksets, exit devices, door closers, etc.) from a single manufacturer.

2.02 MATERIALS

A. SCREWS AND FASTENERS

1. All required screws shall be supplied as necessary for securing finish hardware in the appropriate manner. Thru-bolts shall be supplied for exit devices and door closers where required by code and the appropriate blocking or reinforcing is not present in the door to preclude their use.

B. HANGING DEVICES

1. HINGES

a. Hinges shall conform to ANSI A156.1 and have the number of knuckles as specified, oil-impregnated bearings as specified with NRP (non-removable pin) feature, at all exterior reverse bevel doors. Unless otherwise scheduled, supply one (1) hinge for every 30 inches of door height. Hinges shall be a minimum of 4½ inches high and 4 inches wide; heavy weight hinges (.180) shall be supplied at all doors where specified.

a. Specified Manufacturer: McKinney

b. Approved Substitutes: Bommer, Hager, Stanley

C. CYLINDERS AND KEYING

1. LOCK DESIGN

Locksets, latches, cylinders, and deadlocks shall be the product of one manufacturer. Lock design to be Schlage.

2. KEYING

All locks and cylinders shall be keyed to a new Master Key System, as directed by the Owner. General Contractor shall supply all cylinders with a construction master key for their use during the course of construction. Provide three (3) keys for each cylinder.

D. LOCKING AND EXIT DEVICES

1. MORTISE LOCKSETS

a. The locks and panic bar shall be fire rated and tested in accordance to ANSI A156.3, 1989 Grade 1.

b. The lock/panic bar shall be Von Duprin 22L-F or approved equal. The panic bar to be mounted inside the door shall be Von Duprin 22EO-F.

c. The matching trim to be mounted outside the door shall be Von Duprin 230L with Mortise cylinder. This cylinder shall fit a City provided core by Best Locks. A key shall be used to open the mortise lock and when the key is removed the mortise lock shall lock automatically. The lever style shall be standard, the finish color shall be dark bronze.

d. The City will provide a construction core and one (1) key for Contractor access during construction.

e. Provide one zinc plated pop rod to hold door open 90 and 160 degrees. Provide EPDM extruded rubber weather tight gasket.

E. DOOR CLOSERS

1. SURFACE MOUNTED CLOSERS – HEAVY DUTY

a. All door closers shall be ANSI 156.4, Grade 1 Certified. All surface closers shall be of full rack and pinion construction. Closing speed, latching speed and backcheck shall be controlled by key operated valves. Closers shall be non-handed to meet a variety of door conditions and design requirements, including hold open and stop where indicated. Closers shall project no more than 2¾ inches from the surface of the door. All arms shall be finely finished with heavy-duty forged steel main arm and closer covers shall be of high impact plastic material of flame retardant grade.

a. Specified Manufacturer: Norton 7500 Series

b. Approved Substitutes: Corbin Russwin DC8000 Series, Sargent 281 Series, Yale 400 Series

F. DOOR STOPS

1. FLOOR AND WALL MOUNTED DOOR STOPS

a. Where a door is indicated on the plans to strike flush against a wall, railing or similar, wall bumpers or floor stops shall be provided to best fit design where Hold Open-Stop function Closers are not specified for the particular opening. Provide convex or concave design as indicated.

a. Specified Manufacturers: Rockwood

b. Approved Substitutes: McKinney, Quality, Trimco

G. GASKETING AND THRESHOLDS

1. Provide continuous weatherseal on exterior doors. Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.

2. Provide threshold units not less than 4-inch wide, formed to accommodate change in floor elevation, fabricated to accommodate door hardware and to fit door frames. All threshold units shall comply with the Americans with Disabilities Act (ADA).

a. Specified Manufacturers: Pemko

b. Approved Substitutes: McKinney, Reese, Zero

2.03 FINISHES

H. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18 or traditional U.S. finishes shown by certain manufacturers for their products.

I. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

J. Where specified hardware shall have an antimicrobial coating which permanently suppresses the growth of bacteria, algae, fungus, mold and mildew applied. The finish shall control the spread and growth of bacteria, mold and mildew.

K. Hardware Finishes shall be 626 / 26D for Locksets and 32D for Hinges and Miscellaneous components, and Mill Finish for Thresholds. Should any discrepancies occur for particular hardware pieces, the Owner/City will make the ultimate decision of finish selection during the submittal process.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Ensure that the building is secured and free from weather elements prior to installing interior door hardware. Examine hardware before installation to ensure it is free of defects.

3.02 INSTALLATION

A. Mount hardware units at heights indicated in the following applicable publications, except as specifically indicated or required to comply with the governing regulations.

1. “Recommended Locations for Builders Hardware for Standard Steel Doors and Frames” by the Door and Hardware Institute (DHI.)

B. All hardware shall be applied and installed in accordance with best trade practice by an experienced hardware installer. Care shall be exercised not to mar or damage adjacent work.

C. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal,

storage, and reinstallation or application of surface protection with finishing work specified in Section 09900 – Protective Coating. Do not install surface-mounted items until finishes have been completed on the substrates involved.

D. Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.03 FIELD QUALITY CONTROL

A. Be solely responsible for and have control over construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract, unless the Contract Documents give other specific instructions concerning these matters.

B. Prior to the installation of hardware, manufacturer's representatives for locksets, closers, and exit devices shall arrange and hold a jobsite meeting to instruct the installing contractor's personnel on the proper installation of their respective products. A letter of compliance, indicating when this meeting is held and who is in attendance, shall be sent to the Engineer and the Owner.

C. The hardware supplier shall do a final inspection prior to building completion to ensure that all hardware was correctly installed and is in proper working order.

D. The manufacturer’s representative shall do a final inspection prior to building completion to ensure that all hardware was correctly installed and is in proper working order.

3.04 ADJUSTING, CLEANING AND DEMONSTRATING

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

B. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make a final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore to proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

C. Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.

3.05 PROTECTION

A. Protect all hardware, as it is stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

3.06 HARDWARE SCHEDULE

A. The following schedule is furnished for whatever assistance it may afford the Contractor; do not consider it as entirely inclusive. Should any particular door or item be omitted in any scheduled hardware heading, provide door or item with hardware same as required for similar purposes. Hardware supplier is responsible for handing and sizing all products as listed in the hardware heading. Quantities listed are for each pair of doors, or for each single door. All finishes are intended to compliment a consistent appearance; should any specified finishes create contrasting appearances, substitute to like or complimenting finish and identify in submittal, subject to Owner review and approval.

B. Manufacturer's Abbreviations:

1. CR – Corbin Russwin
2. MC – McKinney
3. NO – Norton
4. PE - Pemko
5. RO – Rockwood
6. VD – Von Duprin
7. KX - Keedex

SET #01 – Main Building Doors

3	Hinges	T4A3386 4-1/2 x 4-1/2 NRP	MC
1	Closer / Stop	CPS-7500-T SRI	NO
1	Weatherstrip	2891AS (@ Head)	PE
2	Weatherstrip	290AS (@ Jambs)	PE
1	Raindrip	346C	PE

1	Door Shoe	211DV	PE

Description of Operation:

Normal State: Closed and locked.

END OF SECTION

SECTION 09900

PAINTING & FINISH SCHEDULE

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of furnishing and applying paint for architectural, structural, mechanical and miscellaneous work as designated in the finish schedule.

The work comprises the painting of all exposed surfaces of concrete, sheet metal, iron and steel, process equipment, electrical equipment, process piping ducts and other miscellaneous items.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 03100: Concrete

C. Section 05500: Metal Fabrication

D. Section 15010: General Process and Onsite Utility Piping Provisions

1.03 SUBMITTALS

A materials list and samples shall be submitted as required by Section 01300 and as follows:

A. Materials list naming each product to be used identified by manufacturer and type number.

B. Volatile organic compound (VOC) level (gm/l) and manufacturer's certification of compliance with applicable air quality limits for each coating.

C. Manufacturer's application recommendations for each product submitted.

D. The Contractor shall submit a current chart of the Manufacturer's available colors for selection by the Engineer, forty five (45) days prior to the start of coating and painting. The Contractor shall furnish to the Engineer for review one 12-inch by 12-inch sheet of galvanized steel with paint system as specified for exterior service, in colors selected by the Engineer. Samples, when reviewed and accepted by the Engineer, shall establish the quality of the painted surface where these applications are indicated.

1.04 DEFINITIONS

A. The term "paint" as used herein includes enamels, paints, sealers, emulsions and other coatings used as prime intermediate or finish coats for protection or decoration.

B. The abbreviation “VS” represents “Volume of solids”

1.05 COMPLIANCE WITH VOLATILE ORGANIC COMPOUND (VOC) LIMITS

All paint and coating products shall comply with the applicable limits on volatile organic compounds (VOC) as established by the United States Environmental Protection Agency and by State and local air quality regulating agencies. It shall be the Contractor's responsibility to verify compliance of all paints and coatings. In the event that any paint or coating listed herein is found to be non-compliant, the Contractor shall notify the Engineer and the Engineer will select a substitute coating or paint.

1.06 QUALITY ASSURANCE

A. General:

Quality assurance procedures and practices shall be utilized to monitor all phases of surface preparation, application and inspection throughout the duration of the project. Procedures or practices not specifically defined herein may be utilized provided they meet recognized and accepted professional standards and are approved by the Engineer.

B. Workmen:

Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

C. Paint Coordination:

1. Review other Sections of these Specifications as required, verifying the prime coats to be used and assuring compatibility of the total coating system for the various substrata.

2. Upon request, furnish information on the characteristics of the specific finish materials to assure that compatible prime coats are used.

3. Provide barrier coats over non-compatible primers, or remove the primer and re-prime as required.

4. Notify the Engineer in writing of anticipated problems in using the specified coating systems over prime-coatings supplied under other Sections.

1.07 DELIVERY AND STORAGE

A. All materials shall be brought to the job site in original sealed containers. Each container shall bear the manufacturer's name, coating type, batch number, date of manufacture, storage life, and special directions. They shall not be used until the Engineer has inspected contents and obtained data from information on containers or label. Materials exceeding storage life recommended by the manufacturer shall be rejected.

B. All coatings and paints shall be stored in enclosed structures to protect them from weather and excessive heat or cold. Flammable coatings or paints must be stored to conform with City, County, State and Federal safety codes for flammable coatings or paint materials. At all times coatings or paints shall be protected from freezing.

1.08 REFERENCED SPECIFICATIONS AND STANDARDS

A. Without limiting the general aspects of other requirements of these specifications, all surface preparation, coating and painting of surfaces shall conform to the applicable requirements of the National Association of Corrosion Engineers, the Steel Structures Painting Council, the American Concrete Institute, the Forest Products Research Society and the Manufacturer's printed instructions.

B. The Engineer's decision shall be final as to interpretation and/or conflict between any on the reference specifications and standards contained herein.

1.09 SPARE SUPPLIES

The Contractor shall provide one unbroken gallon container or kit of each color and type of paint and each type of solvent and thinner required by the specifications. These spare paint supplies shall be stored as required in paragraph 09900-1.07 until delivery is requested by the Engineer.

PART 2: MATERIALS

2.01 PAINT AND FINISH PRODUCTS

A. Paint and coating products shall be fresh and well ground; shall not settle readily, cake, or thicken in the container; shall be broken up readily with paddle to a smooth consistency; and shall have easy application properties. Other painting materials such as linseed oil, turpentine, mineral spirits, miscellaneous thinners, varnish, and shellac shall be of the highest quality.

B. All paints and coatings shall be specifically manufactured for use on projects of this type, and shall be used on surfaces intended by the paint manufacturer. Paints and coatings shall be Tnemec, Ameron/PPG or equal. All paint and coatings shall be delivered in original containers, with seals unbroken.

C. To establish a standard of quality, several specific paint and coating products are listed in the coating System Index under 2.05, this section.

2.02 COMPATIBILITY OF SHOP AND FIELD PAINTS

To ensure a satisfactory painting job it is essential that the paints applied in the shop and in the field be mutually compatible. Where prime coats are shop applied, the Contractor shall instruct suppliers to provide compatible primers with the finish coats selected by the Contractor. In no case will primers be allowed that are not manufactured by the suppliers of the finish coats unless approved by the Engineer.

2.03 COLORS

Color for the various surfaces to be painted shall be selected by the Engineer. Use of different colors for the various structures or for surfaces of a single structure may be directed by the Engineer.

2.04 SYSTEMS INDEX

A. System B: Protective Coal Tar

1. TYPE OF COATING: Protective Coal Tar or Coal Tar Epoxy, minimum 70% VS, two component, suitable for below grade service, meets MIL C200 performance for buried conditions.

2. SURFACE: Buried ferrous metals and concrete

3. COATINGS AND DRY FILM THICKNESS (DFT):

Coat No.	DFT per Coat	Sherwin Williams	Tnemec	PPG
1	10 - 20 mils	Targuard CTE	446	Sigmashield 880
2	10 - 20 mils	Targuard CTE	446	Sigmashield 880

B. System C: 100% Solids Epoxy Lining

1. TYPE OF COATING: 100% Solids Epoxy, non- polluting, solvent free, two-component, 100% solids, high physical characteristics, epoxy system designed as a chemical coating barrier against potable water, salt water and raw wastewater, raw sewer, sulfuric acid, high h2S, and high flow conditions.

2. SURFACE: Ferrous metal and concrete immersed, submerged.

3. SURFACING: Prepared concrete shall be surfaced with epoxy mortar to fill

bugholes, surface irregularities, and provide an acceptable continuous plane for epoxy finish. Epoxy mortar shall be a minimum 1/ 16" thickness.

a. Repair degraded concrete substrate utilizing microsilica mortar for thicknesses above 250 mils.

4. Exterior: Buried exterior concrete shall be coated with an emulsified asphalt coating in accordance with Section 07175.

Concrete					
Coat	DFT per	Sherwin	Tnemec	Hydro Pox	PPG
1	65 – 250	Duraplate 2300	Mortar Clad	Hydro	Raven 760
2	80 – 125	Duraplate 6100	435	04-204HB	Raven 405

Ferrous Metal				
Coat	DFT per	Sherwin	Tnemec	PPG
1	25 - 45 mils	Duraplate 6100	Series 435	Novagaurd 840/890

PART 3: EXECUTION

3.01 GENERAL

A. All surface preparation, coating and painting shall conform to applicable standards of the National Association of Corrosion Engineers, the Steel Structures Painting Council, the American Concrete Institute, the Forest Products Research Society and the Manufacturer's printed instructions. Material applied prior to approval of surface by the Engineer shall be removed and re-applied to the satisfaction of the Engineer at the expense of the Contractor.

B. All work shall be performed by skilled craftsmen qualified to perform the required work in a manner comparable with the best standards of practice.

C. The Contractor shall provide a supervisor at the work site during cleaning and application operations. The supervisor shall have the authority to sign any change orders, coordinate work and make decisions pertaining to the fulfillment of the contract.

D. Dust, dirt, oil, grease or any foreign matter that will affect the adhesion or durability of the finish must be removed by washing with clean rags dipped in an approved cleaning solvent and wiped dry with clean rags.

E. Coatings and painting systems include surface preparation, prime coating and finish

coatings. Unless otherwise specified, prime coatings shall be field applied. Where prime coatings are shop applied, the Contractor shall instruct suppliers to provide the prime coat compatible with the finish coat specified. Any off-site work which does not conform to the specification is subject to rejection by the Engineer.

Shop applied prime coatings which are damaged during transportation, construction or installation shall be thoroughly cleaned and touched up in the field as directed by the Engineer. The Contractor shall use repair procedures which insure the complete protection of all adjacent primer. The specified repair method and equipment may include wire-brushing, hand or power tool cleaning or dry air blast cleaning. In order to prevent injury to surrounding painted areas blast cleaning may require use of lower air pressure, smaller nozzle and abrasive particle sizes, short blast nozzle distance from surface, shielding and masking. If damage is too extensive, the item shall be re-cleaned and coated or painted as directed by the Engineer.

F. The Contractor's coating and painting equipment shall be designed for application of materials and shall be maintained in first class working condition. Compressors shall have suitable traps and filters to remove water and oils from the air. Contractor's equipment shall be subject to approval by the Engineer.

G. Application of the first coat shall follow immediately after surface preparation and cleaning and within an eight hour working day. Any cleaned areas not receiving first coat within eight-hour period shall be re-cleaned prior to application of first coat. This may include re-blasting.

H. Prior to assembly, all surfaces made inaccessible after assembly shall be prepared as specified herein and shall receive the coating or paint system specified.

3.02 SURFACE PREPARATION, METALLIC SURFACES

A. Surface preparation will be based on comparison with: "Pictorial Surface Preparation Standards for Painting Steel Surfaces", SSPC-Vis 1, ASTM Designation D220: "Standard Methods of Evaluating Degree of Rusting on Painted Steel Surfaces", SSPC-Vis 2, ASTM Designation D610; Visual Standard for Surfaces of New Steel Air-blast Cleaned with Sand Abrasive", NACE Standard TM-01-70; and as described below. Anchor profile for prepared surfaces shall be measured by use of a non-destructive instrument such as a Keane-Tator Surface Profile Comparator or Testex Press-O-Film System.

To facilitate inspection the Contractor shall, on the first day of abrasive blast cleaning operations, blast clean metal panels to the standard specified. These panels shall be equivalent to the supplied plate stock which is to be coated or painted and shall have minimum measurements of 8-½-inches by 11-inches. After agreeing a specific panel meets the requirements of the specification, it shall be initialed by the Contractor and Engineer and coated with a clear non-changing

finish. Panels shall be utilized for inspection purposes throughout the duration of blast cleaning operations.

B. Heavy deposits of grease or oil shall be removed with solvent oil cleaner and any chemical contamination shall be neutralized and/or flushed off prior to any other surface preparation in accordance with SSPC-SP1.

C. Surfaces scheduled for Near White or Commercial Blast Cleaning shall have all welds, edges, and sharp corners ground to a 1/16-inch radius and all weld splatter removed, and sandblasted in accordance with Steel Structures Painting Council Specifications, removing mill scale, rust, dirt, paint, or other foreign matter, and shall be slightly roughened to form a suitable anchor pattern for the coating application. Do not leave blasted surfaces overnight before coating. Remove all sand from the surface by brush or industrial vacuum.

D. All other steel not scheduled for blast cleaning shall have all weld splatter removed, and rough edges and rough welds ground, and shall be cleaned by means of hand or power tools, in accordance with Steel Structures Painting Council Specification No. 2 or No. 3, removing all loose mill scale rust, dirt, paint, or other contaminants. Blast cleaning may be used if practical. The remaining mill scale, rust, and paint must be sufficiently abraded to provide for good bonding of the coating.

E. Field blast cleaning for all surfaces shall be dry method unless otherwise directed.

F. Particle size of abrasives used in blast cleaning shall be that which will produce a 2 mil (50.0 microns) surface profile or in accordance with recommendations of the manufacturer of the specified coating or paint system to be applied.

G. Abrasive used in blast cleaning operations shall be new, washed, graded and free of contaminants that would interfere with adhesion of coating or paint and shall not be reused unless specifically approved by the Engineer.

H. During blast cleaning operations, caution shall be exercised to insure that existing coatings or paints are not exposed to abrasion from blast cleaning.

I. The Contractor shall keep the area of his work in a clean condition and shall not permit blasting materials to accumulate as to constitute a nuisance or hazard to performance of work or operation of existing facilities.

J. Blast cleaned surfaces shall be cleaned prior to application of specified coatings or paints by a combination of blowing with clean dry air, brushing/brooming and/or vacuuming as directed by the Engineer.

K. All welds shall be cleaned with a suitable chemical compatible with the specified coating materials.

L. Application SSPC specifications are as follows:

1. SOLVENT CLEANING (SSPC-SP1): Removal of oil, grease, soil and other contaminants by use of solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods which involve a solvent or cleaning action.

2. HAND TOOL CLEANING (SSPC-SP2): Removal of loose rust, loose mill scale and other detrimental foreign matter to degree specified by hand chipping, scraping, sanding, and wire-brushing.

3. POWER TOOL CLEANING (SSPC-SP3): Removal of loose rust, loose mill scale and other detrimental foreign matter to degree specified by power wire-brushing, power impact tools or power sanders.

4. WHITE METAL BLAST CLEANING (SSPC-SP5): Blast cleaning to a gray-white uniform metallic color until each element of surface is free of all visible residues.

5. COMMERCIAL BLAST CLEANING (SSPC-SP6): Blast cleaning until at least two-thirds of each element of surface area is free of all visible residues.

6. BRUSH-OFF BLAST CLEANING (SSPC-SP7): Blast cleaning to remove loose rust, loose mill scale and other detrimental foreign matter to degree specified.

7. NEAR WHITE BLAST CLEANING (SSPC-SP10): Blast cleaning to nearly white metal cleanliness, until at least 95 percent of each element of surface area is free of all visible residues.

8. BRUSH OFF ABRASIVE BLAST CLEANING OF NON FERROUS METALS (SSPC-SP16)

M. Specific Surface Preparation: Surface preparation for the specific substrates shall be as designated as follows

1. New Ferrous Metal: Immersed, Submerged, Buried, SSPC-SP10, 3 – 5 mil profile for coating systems above 20 mils dft. Shop primed items for immersion shall be prepared in accordance with manufacturer's procedure for acceptable finish coat condition.

2. New Galvanized Metal: Immersed, Submerged, Buried, SSPC-SP16, 0.75 – 1.5 mil profile

3. New Ferrous Metal, Structural, Piping, Valves, Atmospheric: SSPC-SP6, 1.5 – 2 mil profile

4. New Ferrous Metal, Equipment, Shop Primed, Atmospheric: Shop performed SSPC-SP6, 1.5 – 2 mil profile

5. New Non Ferrous Metal, Structural, Piping: Atmospheric: SSPC-SP16, 0.75 – 1.5 mil profile. For atmospheric item in low corrosive environment, clean surfaces using phosphoric acid based detergent and rinse. Completely and thoroughly abrade surfaces utilizing 100 grit sandpaper or similar to impart profile and remove passivation layers. Confirm removal of passivation layers using methods defined in SSPC-SP16.

6. New Hollow Metal, Shop Primed: Clean per SSPC-SP1. Completely and thoroughly abrade shop applied primer. Remove any corrosion rust per SSPC-SP11 and prime with epoxy primer.

7. New Items, Shop Primed, Atmospheric: Clean per SSPC-SP1. Completely and thoroughly abrade shop applied primer. Remove any corrosion rust per SSPC-SP11 and prime with epoxy primer.

8. **Ductile Iron, Exposed, Submerged: If supplied, or existing with asphaltic coating, abrasive blast clean in accordance with NAPF-003.**

3.03 SURFACE PREPARATION, CONCRETE AND MASONRY

A. New concrete and masonry shall cure at least 28 days and have a moisture content prior to coating or painting below 8 percent as measured by an instrument such as a Delmhorst Model DP, unless recommended otherwise by the paint manufacturer.

B. All surfaces shall be thoroughly cleaned by abrasive blasting, wire-brushing or other approved methods, removing all traces of foreign materials in accordance with SSPC-SP13. Remove all loose concrete and masonry by chipping or other approved methods to leave only a sound, firmly bonded substrate. Remove all existing coating, surfacing materials from existing substrates where immersed, submerged conditions are expected to provide exposed substrate for subsequent repair.

C. Cracks and voids shall be repaired or filled as directed by the Engineer with approved suitable materials, mixed and applied in strict accordance with the Manufacturer's printed instructions. In general, final surface shall be smooth and free of voids, cavities, dirt, dust, oils, grease, or other contaminants.

D. Where oil or grease deposits are present, prior to above surface preparation, clean surfaces by scrubbing with a solution of one and one-half ounces (44.4 ml) tri-sodium phosphate (TSP) and one and one-half ounces (44.4 ml) of non-sudsing detergent mixed into one gallon (3.785 liters) of warm water. Surfaces shall then be flushed clean with fresh water.

E. Specific Surface Preparation: Surface preparation for the specific system shall be as designated in the Systems Index, Part 2.05 of these specifications.

1. Concrete, Masonry, Brick, Immersed, Submerged, Chemical Containment: Dry abrasive blast clean per SSPC-SP13. Impart appropriate surface profile in accordance with ICRI 310.2, CSP 4 – 6 for lining systems and minimum CSP 6 for repair of degraded substrate. Utilize manufacturer's suggested epoxy mortar surfacing for newly constructed surfaces and microsilica mortar surfacing for repair of degraded existing substrates.

2. Concrete, Masonry, Brick, CMU, Buried, Below Grade: Dry abrasive blast or mechanically clean per SSPC-SP13. Impare surface profile in accordance with ICRI 310.2 , CSP 2 – 5.

3. Concrete, Masonry, Brick, CMU, Atmospheric: Dry abrasive blast or mechanically clean per SSPC-SP13. Impart surface profile in accordance with ICRI 310.2, CSP 2 – 5. Wet abrasive, vapor abrasive, or water jetting alternates may be submitted for review.

3.04 SURFACE PREPARATION OF CPVC, PVC, PLASTICS, AND FIBERGLASS

A. Plastics, PVC, CPVC, and Fiberglass substrates requiring protection from UV, atmospheric exposure shall be cleaned to remove oils, residual glues, and foreign contaminants per SSPC-SP1. Surfaces shall be rinsed cleaned. Do not use hydrocarbon based solvents for waterbased acrylic primers or finishes.

B. Completely and thoroughly abrade all surfaces utilizing 100 grit paper or similar to provide a clean, dull, profiled surface acceptable for epoxy primer.

3.05 SURFACE PREPARATION, WOOD AND COMPOSITION MATERIALS

A. Wood and composite materials shall have a moisture content prior to coating or painting below 15 percent as measured by an instrument such as a Delmhorst Model BD-7, unless recommended otherwise by the paint manufacturer.

B. All surfaces shall be thoroughly cleaned by use of mineral spirits, scrapers, sandpaper. or wire brushes to remove all dirt, oil, grease or other foreign substances. Finished surfaces exposed to view shall, if necessary, be made smooth by planing or sandpapering. Small, dry, seasoned knots shall be scraped, sandpapered, and thoroughly cleaned, and shall be given a thin coat of WP-578 Western Pine Association knot sealer before application of the priming coat. Large, open unseasoned knots, and all beads or streaks of pitch shall be scraped off, or if the pitch is still soft, it shall be removed with mineral spirits and the resinous area shall be thinly coated with knot sealer. After priming, all holes and imperfections shall be filled with putty or plastic wood (colored to match the finish wood), allowed to dry, and sandpapered smooth. Painting of interior wood and composite materials shall proceed insofar as practicable, only after masonry work has dried. Existing surfaces shall be cleaned of all loose or flaking paint and sandpapered as required.

3.06 SURFACE PREPARATION OF SHOP PRIMED, SHOP FINISHED ITEMS TO RECEIVE FIELD FINISH COAT

A. Shop primed surfaces to be finished in the field shall be thoroughly cleaned per SSPC-SP1. Shop applied primers shall be completely and thoroughly abraded. Remove all loose, damaged coatings in accordance with SSPC-SP2 or SP3. Provide primers for exposed substrates in addition to specified finish coats.

B. Cabinets, HVAC, or other factory applied baked finishes to be over coated to match existing color scheme shall be cleaned per SSPC-SP1 and completely and thoroughly abraded to provide a clean, dull, profiled substrate for subsequent painting.

3.07 SURFACE PREPARATION OF EXISTING COATED SURFACES TO RECEIVE NEW FINISH COAT

A. Existing coatings to be overcoated shall be thoroughly cleaned per SSPC-SP1. Abrasive brush blast clean all coated surfaces per SSPC-SP7. Where loose coating has been removed, abrasive blast clean exposed substrates according to the requirements of the base substrate, SSPC-SP6 for ferrous metal, SP16 for non-ferrous metal, or SSPC-SP12 for concrete.

B. In the event that abrasive blasting is not possible, provide alternate mechanical preparation proposals for engineering review.

3.08 COATING APPLICATION

A. Coating and paint application shall conform to the requirements of the Steel Structures Painting Council Paint Application Specifications SSPC-PA1, latest revision, for "Shop, Field and Maintenance Painting", and recommended practices of the National Association of Corrosion Engineers, the American Concrete Institute, the Forest Products Research Society and the Manufacturer of the paint and coating materials.

B. Before applying any paint or finish, all surfaces shall be thoroughly cleaned and prepared for painting as herein specified. All cleaned metal shall be primed or painted, as specified, immediately after cleaning to prevent new rusting or oxidation of cleaned surfaces.

C. Protective coverings or drop cloths shall be use to protect floors, fixtures, and equipment. Care shall be exercised to avoid lapping on glass or hardware. Coatings and paints shall be sharply cut to lines. Finished surfaces shall be free from defects or blemishes.

D. Application:

No coating or paint shall be applied:

1. When the surrounding air temperature or the temperature of the surface to be coated or painted is below 40 degrees F.

2. To wet or damp surfaces or in rain, snow, fog or mist.

3. When the temperature is less than 5 degrees F above the dewpoint.

4. When it is expected the air temperature will drop below 40 degrees F or less than 5 degrees F above the dewpoint within eight hours after application of coating or paint

Dewpoint shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with the US Department of Commerce Weather Bureau Psychometric Tables.

If above conditions are prevalent, coating or painting shall be delayed or postponed until conditions are favorable, unless conditions are acceptable to the paint manufacturer for any given coating. The days coating or painting shall be completed in time to permit the film sufficient drying time to prevent damage by atmospheric conditions.

E. All painting shall be well applied, leaving no sags, laps, brush, or other defects. Each coat must thoroughly dry before applying next coat, and all work must be carefully cut into a true line and left smooth and clean. Hardware trim and other items shall be removed as required for proper application of coatings.

All painting shall conform to the following general conditions:

1. Thickness of coating in mils shall mean the dry film thickness. The number of coats specified shall mean the minimum number of coats to be used. Additional coatings shall be required if necessary to obtain the specified film thickness.

2. No coating work shall be done under unfavorable weather conditions.

3. Prime coats shall be provided where called for as a part of the painting system. Shop prime coats shall conform to the specified painting system for the given item. It shall be the responsibility of the Contractor to coordinate work so that factory prime items are primed or painted with a coating compatible with the specified finish painting system.

4. Particular attention shall be given to all welds, edges, and corners so as to get full and adequate coverage. Damaged shop prime coats or field applied prime coats shall be carefully replaced before finish painting. Surface preparation for replacement of damaged coats shall be such as to give a clean surface for proper bonding of prime coat. Finish coatings shall not be applied until touch-up prime coat has completely dried.

5. Minimum between coat drying items, as stated in the printed instructions of the coating manufacturer will be carefully observed.

6. Thinning shall be done only if necessary for workability of the coating material in accordance with the manufacturer's printed instructions. Use only the appropriate thinner.

7. Each coat shall be applied in a different color from the preceding coat, the finish coat to be color selected by the Engineer. When a white finish color is desired, the last two coats shall be white.

8. Where installed coatings or linings are to be placed in submerged, partially submerged or immersed conditions, provide a pinhole free, monothlic film, fully cured prior to placing into service. Provide detailed reports of inspection and repair activity.

3.09 SPECIAL REQUIREMENTS FOR GALVANIZED AND NON-FERROUS METALS

A. Where galvanized or non-ferrous metals are scheduled to be painted, the surface shall be brush blasted in accordance with SSPC-SP16 before finish are applied. Do not remove the galvanized coating. Damaged areas should be repaired with an appropriate zinc-rich primer or cold galvanizing compound with greater than 80% zinc content in the dried film, such as Tnemec Series 90-97, Sherwin Williams Zinc Clad III HS

3.10 INSPECTION

A. Inspection - General:

Concrete, plastic and wood surfaces shall be visually inspected to insure specified coverage has been attained. Where destructive testing is deemed necessary, an instrument such as a Tooke Gage shall be used. Thickness of coatings and paints on metal surfaces shall be checked with a non-destructive type thickness gauge. Coating integrity shall be tested with an approved inspection device. Holiday detection shall be performed prior to the application of aluminum or metallic finish coats. Holiday detectors shall not exceed the voltage recommended by the manufacturer of the coating system. For film thickness between 10 and 20 mils, a non-sudsing type wetting agent such as Kodak Photo-Flo shall be added to the water prior to wetting the detector sponge. All pinholes shall be marked, repaired in accordance with the manufacturer's recommendations and retested. No pinholes or other irregularities will be permitted in the final coating.

In cases of dispute concerning film thickness or holidays, the Engineer's calibrated instruments and measurements shall predominate. Wide film thickness discrepancies shall be measured and verified with a micrometer or other approved measuring instrument.

B. Inspection Devices:

The Contractor shall furnish, until final acceptance of coating and painting, inspection devices in good working condition for detection of holidays and measurement of dry-film thickness of coating and paint. The Contractor shall also furnish US Department of Commerce, National Bureau of Standards certified thickness calibration plates to test accuracy of dry-film thickness gauge and certified instrumentation to test accuracy of holiday detectors.

Dry-film thickness gauges and holiday detectors shall be made available for the Engineer's use at all times until final acceptance of application. Holiday detection devices shall be operated in the presence of the Engineer.

Acceptable devices for ferrous metal surfaces include, but are not limited to Tinker-Rasor Model M-1 holiday detector for coatings to 20 mils dry film thickness, Tinker-Rasor Models AP and AP-W holiday detectors for coatings in excess of 20 mils dry-film thickness, and Mikrotest or Positest unit for dry-film thickness gauging. Non-ferrous metal surfaces shall be checked with an instrument such as an Elcometer "Eddy Current" Tester or De Felsko Model 252. Inspection devices shall be operated in accordance with the manufacturer's instructions.

3.11 SAFETY AND HEALTH REQUIREMENTS

A. General:

In accordance with requirements set forth by regulatory agencies applicable to the construction industry and Manufacturer's printed instructions and appropriate technical bulletins and manuals, the Contractor shall provide and require use of personnel protective lifesaving equipment for persons working in or about the project site.

B. Head and Face Protection and Respiratory Devices:

Equipment shall include protective helmets which shall be worn by all persons in the vicinity of the work. In addition, workers engaged in or near the work during abrasive blasting shall wear eye and face protection devices and air purifying, half-mask or mouthpiece respirator with appropriate filter. Barrier creams shall be used on any exposed areas of skin.

C. Ventilation:

Where ventilation is used to control hazardous exposure, all equipment shall be explosion-proof. Ventilation shall reduce the concentration of air contaminant to the degree a hazard does not exist. Air circulation and exhausting of solvent vapors shall be continued until coatings have fully cured.

D. Sound Levels:

Whenever the occupational noise exposure exceed maximum allowable sound levels, the Contractor shall provide and require the use of approved ear protective devices.

E. Illumination:

Adequate illumination shall be provided while work is in progress, including explosion-proof lights and electrical equipment. Whenever required by the Engineer, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the Engineer.

F. Temporary Ladders and Scaffolding:

All temporary ladders and scaffolding shall conform to applicable safety requirements. They shall be erected where requested by the Engineer to facilitate inspection and be removed by the Contractor to locations requested by the Engineer.

3.12 PRESERVATION

During construction, painter shall assume the preservation of all his work against damage by accident or otherwise, and shall leave the work clean and whole. The work will not be accepted until all of the work has been completed and all retouching has been done. All work which is rejected, or for any reason has to be done over, will be done by the Contractor at his expense.

3.13 CLEANING

During the progress of the work, all other work shall be covered and fully protected from injury or painter's finish, and care shall be exercised not to splatter paint, enamel, etc., on adjacent work. Upon completion of the work, all staging, scaffolding and containers shall be removed from the site or destroyed in a manner approved by the Engineer. Name and data plates on equipment shall not be painted and shall be left clean and legible upon completion of the project. All damage to surfaces resulting from the work of this section shall be cleaned, repaired, or refinished to the satisfaction of the Engineer at no expense to the Agency.

3.14 FINISH SCHEDULE

The following is a partial schedule and does not include all surfaces that require coatings. Coat unlisted surfaces with the same coating system as similar listed surfaces. Additional coating requirements are included with the architect's drawings and specifications for the buildings.

System "A" Polymidoamine Epoxy:

Exterior of all piping and valves except for stainless steel piping.

Submerged pipe supports and hangers except for stainless steel.

Exterior of submerged pumps, mixers, motors and other equipment.

Bell rings and underside of manholes covers and frames.

Field priming of ferrous metals surfaces with defective shop prime costing or where no other prime coating is specified.

Cast iron sluice gates and stem guides.

All other submerged iron and steel metal unless specified otherwise.

System "B" Protective Coal Tar: Underground pipe flanges, corrugated metal pipe couplings, flexible pipe couplings, and miscellaneous underground metals not specified to receive another protective coating system.

System "C" 100% Solids Epoxy:

Interiors of new manhole and new wet well, unless specifically identified on drawings. Apply coating prior to drilling and installing pipe and anchors and supports.

System "D" Polyamidoamine Epoxy, Polyurethane:

Doors, door frames, ventilators, louvers, grilles, exposed sheet metal, and flashing.

Exterior piping, valves, pipe hangers and supports, electrical conduit, and other supports except for stainless steel.

Valve and gate operators and stands.

Structural steel including galvanized steel.

Process equipment (not submerged) including pumps, motors, equipment guards, equipment supports and other miscellaneous metals except for stainless steel and aluminum.

Cranes and hoist rails.

Exposed plastic and fiberglass piping, and ductwork.

Exposed PVC piping and valves.

Electrical antenna masts and supports.

Exterior electrical cabinets, boxes, and exposed conduits that are not factory painted.

All other miscellaneous exposed metals and plastics unless specified otherwise.

System "E" Polymidoamine Epoxy: Not used unless indicated on drawings.

System "F" Acrylic Epoxy: Not used unless indicated on drawings.

System "G" Modified Aliphatic Amine Epoxy: Not used unless indicated on the drawings.

System "H" Aliphatic Polyurethane: Not used unless indicated on the drawings.

System "I" Latex Acrylic, Semi-Gloss: Not used unless indicated on the Drawings.

System "J" Resinous Flooring: Not used unless indicated on the drawings.

System "K" Polyurea Elastomer: Not used unless indicated on the Drawings.

System "L" High Build Acrylic: Not used unless indicated on the Drawings.

System "M" Wax: Not used unless indicated on the Drawings.

System "N" Emulsified Asphalt Coating (See Section 07175): Exterior buried walls for

damp proofing the Manhole and Wet Well Exteriors.

System "O" Aromatic Elastomeric Polyurethane, or Epoxy: Not used unless indicated on the Drawings.

System "P" Polyamide Epoxy: Not used unless indicated on the Drawings.

System "Q" Vinyl Ester: Not used unless indicated on the Drawings.

System "R" Flexible Polyurethane: Not used unless indicated on the Drawings.

System “S” Fusion Epoxy: Not used unless indicated on the Drawings.

System “T” Self-Crosslinking Acrylic: Not used unless indicated on the Drawings.

System “U” Semi Gloss Silicone Trim Enamel: Not used unless indicated on the drawings.

END OF SECTION

SECTION 10400

IDENTIFYING DEVICES

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of providing safety signs, identifying devices for buildings, structures, piping, valves, and underground warning tapes for buried utilities.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 15010: General Process and Onsite Utility Piping Provisions

1.03 SUBMITTALS

A. In accordance with Section 01300.

B. Samples of sign materials, colors and exterior letters, along with manufacturer's literature and shop drawings.

C. Submit a complete schedule of all signs, including sign label, type, location and support.

PART 2: MATERIALS

2.01 SIGNS - GENERAL

A. Colors, legends, and layout shall conform to OSHA 1910.145 requirements.

B. Overall size of signs 10 inches X 14 inches or as specified below.

C. Material:

1/8-inch thick rigid Butyrate (BSR) or fiberglass with printed message and background sealed within a fiberglass resin, suitable for outdoor weather conditions. Seton Name Plate Corporation, New Haven, CT 06505; W.H. Brady Company Milwaukee, WI 53201, or equal.

2.02 "DANGER" SIGNS

Two-inch high white letters "Danger" in red oval surrounded by a rectangular black field. Text wording 1½-inch high black capital letters on white field.

No. of Signs	Text Wording	Location

Required		
2	"HIGH VOLTAGE"	As directed by the Engineer
2	"EQUIPMENT STARTS AUTOMATICALLY"	As directed by the Engineer
2	"NO TRESPASSING"	As directed by the Engineer

2.03 WARNING SIGNS

Wording as shown in the plans for recycled water.

No. of Signs Required	Text Wording / Size	Location
2	See Plans	Hose bibs at Will S. Green Pump Station
8	See Plans / 30" x 17"	Fences at WWTP and Farm Fields as directed by the Engineer

2.04 IDENTIFICATION OF PIPING AND VALVES

A. Piping: Plastic markers for coding pipe shall conform to ANSI A13.1 and shall be as manufactured by W.H. Brady Company, Seton Name Plate Corporation, or equal. Markers shall be the mechanically attached type that are easily removable; they shall not be the adhesive applied type. Markers shall consist of pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe.

Plastic zip ties shall not be allowed for fastening.

Legend and backing shall be resistant to petroleum based oils and grease shall meet criteria for humidity, solar radiation, rain, salt, and fog and leakage fungus, as specified by MIL-STD-810 C. Markers shall withstand a continuous operating temperature range of -40°F to +180°F. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.

Markers shall be provided in the following letter heights:

Outside Pipe Diameter (inches*)	Letter Height (inches)
Less than 1-½	½
1-½ through 3	1- ⅛
Greater than 3	2-¼

* Outside pipe diameter shall include insulation and jacketing.

In addition, pipe markers shall include uni- and bi-directional arrows in the same sizes as the legend.

Colors of identification and letters shall comply with the legend below and with ANSI A13.1. See Section 15010 for color code usage.

Pipe Identification Color	Background Color	Color of Lettering/Arrows
1	Yellow	Black
2	Green	White
3	Blue	White
4	Purple	White

B. Valves: Valve tags shall be 2½ inches by 2½ inches, custom engraved (one side) plastic for interior labels and anodized aluminum for exterior. Provide three lines engraving, up to eight characters per line. Background colors shall be reduction, blue, yellow, or green, as specified. Wording and colors to be specified at a later date.

Valve tags shall be as manufactured by Seton Nameplate Corporation, New Haven, Connecticut; Emed Company, Buffalo, NY; or equal

2.05 UNDERGROUND WARNING TAPE

A. Tape shall be 2 inches wide, detectable type, polyethylene or polyester top and bottom, with metallic core completely sealed inside. Tape shall be color coded as specified below and shall be printed with a two-line message. Top line shall read "CAUTION CAUTION...", bottom line shall read as indicated below, or

equivalent:

TYPE SERVICE	COLOR	BOTTOM LINE OF MESSAGE
GAS	YELLOW	"BURIED GAS LINE"
ELECTRIC	RED	"BURIED ELECTRIC LINE"
TELEPHONE	ORANGE	"BURIED TELEPHONE LINE"
WATER	BLUE	"BURIED WATER LINE"
SEWER	GREEN	"BURIED SEWER LINE"
ALL OTHER PIPELINES	YELLOW	"BURIED PIPELINE"

B. Underground warning tape shall be as manufactured by Seton Name Plate Corporation, New Haven, CT; W.H. Brady Company, Milwaukee, WI; or equal.

PART 3: EXECUTION

3.01 MOUNTING SAFETY AND CHEMICAL SIGNS

A. Install the signs at the locations designated by the Engineer.

B. Mount signs with top of the sign 5'-6" above the floor.

C. Secure with No. 10 stainless steel screws, providing expansion shields for concrete.

D. Plastic ties shall not be used for fastening.

E. Mounting holes in signs shall be oversized to allow signs to "float" free.

3.02 IDENTIFYING DEVICES FOR PIPING AND VALVES

A. Piping: Identify all piping at approximately 10-foot centers and in general, at each valve and piece of equipment, but not less than once in each room whether or not concealed.

B. Install valve tags on all process and main utility valves. Tags are not required on hose bibs, faucets, and similar applications. Attach tags to handwheel or stem using stainless steel cable; submit for approval.

3.03 UNDERGROUND WARNING TAPE

A single line of tape as specified in this section shall be provided above the centerline of all buried pipe and conduit. Unless shown otherwise on the drawings, tape shall be installed 6 inches below finished grade. Tape shall be laid flat with message side up before backfilling.

END OF SECTION

SECTION 11010

GENERAL MECHANICAL EQUIPMENT PROVISIONS

PART 1: GENERAL

1.01 DESCRIPTION

This section contains items that pertain to all mechanical work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01010: General Construction Information and Requirements

B. Section 01020: Modification of Existing Facilities and Order of Work

C. Section 01300: Submittals

D. Section 03100: Concrete

E. Section 09900: Painting

F. Section 15080: Piping Accessories and Appurtenances

G. Section 16050: General Electrical

1.03 WORK INCLUDED

The work consists of completely installing the mechanical systems as shown on the drawings and specified in other sections.

1.04 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Comply with all applicable codes, rules, and regulations.

B. References: Comply with referenced standards as listed in the individual sections.

C. Fees and Permits: Obtain required permits necessary to execute the work under this division.

D. All pressure vessels, safety devices and appurtenances shall comply with standards of and bear stamp of ASME.

E. All electrical devices and wiring shall comply with standards of NEC. All devices shall be UL listed and so identified.

F. Testing: All mechanical equipment shall undergo the minimum factory and field

testing as specified herein and Section 01010. Additional testing requirements over and above those specified herein may be included in the individual equipment specifications. These requirements shall be considered complimentary to the minimum requirements specified herein.

1.05 DRAWINGS

Drawings are diagrammatic and show the general design, arrangement and extent of the systems. Do not scale drawings for roughing in measurements, nor use as shop drawings. Make field measurements and prepare shop drawings as required. Coordinate work with shop drawings of other specification divisions.

1.06 SUBMITTALS: In accordance with Section 01300.

A. Detailed submittal requirements are given in the individual sections.

B. Contractor shall investigate the capacity and space requirements of the proposed equipment before submitting shop drawings.

C. Factory test reports shall be submitted for acceptance prior to shipment of the equipment to the job site. Field test reports shall be submitted for acceptance prior to final acceptance of the equipment.

D. Factory test procedures shall be submitted to the engineer for approval prior to commencement of any factory testing.

E. Seismic and structural anchoring calculations shall be submitted to the engineer for approval prior to installation of equipment.

F. Operation and Maintenance manuals shall be submitted to the engineer for approval prior to acceptance of equipment.

1.07 PRODUCT HANDLING

Protect material, equipment, and apparatus provided under this section from damage, water and dust, both in storage and installed, until final acceptance. Provide temporary storage facilities for material and equipment. Material, equipment, or apparatus damaged because of improper storage or protection will be rejected.

1.08 JOB CONDITIONS

A. <u>Special Requirements</u>

1. Maintain emergency and service entrances usable to pedestrian and vehicle traffic at all times. Where trenches are cut, provide adequate bridging for traffic.

2. Coordinate shutdown of water, wastewater, or heating systems.

B. Schedule of Work: Arrange work to comply with schedule of construction. In scheduling, anticipate means of installing equipment through available openings in structure. See Section 01020.

C. Protection

1. Completely cover motors and other moving machinery to protect from dirt, dust, and water during construction.

2. Cap all openings in pipe and ductwork to protect against entry of foreign matter.

3. Protect premises and work of other divisions from damage arising out of installation of work of this division.

4. Perform work in manner precluding unnecessary fire hazard.

1.09 SPECIAL TOOLS

At completion of project, provide one set of special tools required to operate, adjust, dismantle, or repair any equipment of this division, as specified in the individual sections for specific pieces of equipment. Special tools mean those not normally found in possession of mechanics or maintenance personnel.

PART 2: MATERIALS

2.01 GENERAL

A. All the mechanical equipment to be shipped disassembled shall be assembled in the manufacturer's shop to insure proper fitting of parts, then match-marked for erection, and disassembled for shipment.

B. Contractor shall be responsible for locating and installing sleeves, inserts, and supports as required during the stages of construction.

C. Contractor shall be responsible for making minor changes in the piping, and equipment locations due to structural obstructions or conflicts with work specified in other divisions.

2.02 FABRICATED STEEL

A. All steel members used in the fabrication of the equipment shall conform to the requirements or "Specifications for Structural Steel". ASTM A36. All stainless steel shall be Type 316 unless otherwise specified.

B. Design and fabrication of Structural Steel Members shall be in accordance with the latest edition of AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel Plates, Bars and Strip," Designation A-123, or of the ASTM Standard Specifications for Zinc Coating (Hot Dip) or Iron and Steel Hardware, Designation A153067, as appropriate for Buildings. All welding shall conform to the latest standards of the American Welding Society.

C. All parts shall be amply proportioned for all stresses which may occur during fabrication, erection, and operation.

2.03 BOLTS, NUTS, AND WASHERS

Bolts for the equipment assembly shall be hexagonal, refined bar iron, except where the equipment body is stainless steel, aluminum, or bronze alloy, the bolts shall be the same corrosion resistant material. Nuts shall be hexagonal, of the same metal as the bolts. All threads shall be clean cut and shall conform to US Standard B1.1 for Unified Screw Threads.

2.04 NAMEPLATES

Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with oval head stainless steel screws or drive pins. Nameplates to have ¼-inch letters with Equipment Name and number as shown on “P Series” Contract Drawings.

2.05 EQUIPMENT MOUNTS, GROUTING, AND VIBRATION ISOLATION

A. Where a steel or cast base is shown between the equipment and a concrete pedestal, it shall be painted after fabrication in conformance with applicable provisions of Section 09900. It also shall be equipped with drain pans and drain connections, where applicable.

B. All concrete plan dimensions for bases or pedestals shall be at least 2 inches larger in each dimension than the steel or cast base installed thereon. Conduits, piping connections, drains, etc., shall be installed as shown on the Drawings, and/or standard mechanical details.

C. Where specified or noted in the Drawings, the equipment including the base, shall be mounted on or suspended from vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the supporting structure. Vibration isolation available internally in the equipment unit is not equivalent and shall not be provided when vibration isolation as specified herein is required. Normally provided internal vibration isolators need be replaced with rigid supports in such cases.

D. Details of the vibration isolators where required by certain units of mechanical

equipment are included in the Specifications for furnishing and installing those units.

E. Furnish all necessary materials and construct suitable raised concrete foundations for all equipment installed, even though such foundations may not be indicated on the Drawings. The tops of foundations shall be at such elevations as will permit grouting as specified below.

F. In setting pumps, motors, and other items of equipment customarily grouted, make an allowance of at least one inch for grout under the equipment bases. All shims shall be removed. Unless otherwise approved, all grout shall be an approved non-shrink grout.

G. Grout shall be mixed and placed in accordance with the Manufacturer's installation instructions and/or Section 03100, whichever is more stringent. Where practicable, the grout shall be placed through the grout holes in the base and worked outward and under the edges of the base and across the rough top of the concrete foundation to a peripheral form so constructed as to provide a suitable chamfer around the top edge of the finished foundation.

H. Where such procedure is impracticable, the method of placing grout shall be as approved. After the grout has hardened sufficiently, all forms, hoppers and excess grout shall be removed, and all exposed grout surfaces shall be patched in an approved manner, if necessary, given a burlap-rubbed finish, and painted with at least two coats of an approved paint.

I. Equipment control panels and electrical devices and instrumentation mountings shall be provided as shown and as referenced in Section 16010, Appendix “A” Panel and Equipment Index.

2.06 ANCHOR BOLTS

A. General

1. Anchor bolts for all equipment and appurtenances shall be furnished and installed as specified herein and/or as shown on the Drawings. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 25 percent, up to a limiting maximum over-sizing of ¼-inch. Minimum anchor bolt diameter shall be 1/2 inch. All anchor bolts shall be furnished with leveling nuts, the faces of which shall be tightened against flat surfaces as shown to not less than 10 percent of the bolt's safe tensile stress. Anchor bolts shall have a minimum of 2 and not more than 8 threads beyond nuts.

   Equipment manufacturer shall provide structural and seismic calculations for all equipment weighing more than 400 pounds, over 3 feet tall and as

noted in each specification. In addition, any equipment weighing more than 50 pounds that is hung from the structure above or from a wall shall have structural calculations. Structural calculations and details shall conform to the requirements of the UBC including Section 1632. Calculations shall be signed and stamped by a California Registered Civil or Structural Engineer.

a. Seismic Data - The following information is provided for the Contractor's use in seismic calculations and anchor bolt size and embedment (See Geotechnical Report by Wallace Kuhl 8/20/21)

2. It shall be the responsibility of the equipment manufacturer to determine the number, size, and location of all anchor bolts to be set in concrete. Unless indicated otherwise on the drawings, anchor bolts, nuts, and washers shall be galvanized steel, except in wet or corrosive locations they shall be Type 316 stainless steel.

3. Obtain anchor bolt templates from the equipment manufacturer to aid in locating anchor bolts in the concrete pad.

4. No equipment shall be anchored to vertical or overhead structural elements without written approval of the Engineer.

B. Other Considerations

1. Vibration-isolated equipment shall be provided with snubbers capable of retaining the equipment in its designated locations without any material failure or deformation of the snubbers when exposed to a vertical or horizontal force at the contact surface equal to 100 percent of the operating weight of the equipment. Air gaps between retainer and equipment base shall not exceed 1/4 inch.

2. In as much as most anchorage of equipment is to be made of poured-in-place concrete elements, it is imperative that types of anchorage be coordinated with the Contractor so that anchorage may be installed at time of pouring. If calculations and anchorage details are not submitted prior to pouring of concrete, the Contractor will become responsible for any strengthening of concrete elements because of superimposed seismic loading.

3. All piping, raceways, ductwork, accessories, appurtenances, etc., furnished with equipment shall be anchored to resist a lateral seismic force of 40 percent of its operating weight without excessive deflection. This force shall be considered acting at the center of gravity of the piece under consideration.

4. Piping with flexible connection and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping

system.

2.07 BELT DRIVES

A. V-belt with cast iron sheaves rated not less than 1-1/2 times motor horsepower.

B. Multiple V-belts shall be matched sets.

2.08 SHAFT COUPLINGS

A. Shaft couplings for direct connected electric motor driven equipment 1/2 horsepower or larger shall be non-lubricated type, designed for not less than 50,000 hours of operating life. Where requirements of the equipment dictate specialized features, the manufacturer may substitute the coupling normally supplied for the service.

B. Coupling sizes shall be as recommended by the manufacturer for the specific application, considering horsepower, speed of rotation, and type of service. The use of couplings as specified herein shall not relieve the Contractor of his responsibility for precision alignment of all driver-driven units as specified by the equipment manufacturer.

C. Couplings shall be of the pin and pre-loaded neoprene cylinder type, designed to accommodate shock loading, vibration and shaft misalignment or offset. Stub shafts shall be connected through collars or round flanges firmly keyed to their shafts, to neoprene cylinders held to individual flanges by through pins. Couplings with cylinders pinned to both coupling flanges will not be acceptable.

2.09 BEARINGS

Unless otherwise specified all equipment bearings shall be oil or grease lubricated, ball or roller anti-friction type of standard manufacturer. Bearings shall be conservatively designed to withstand all stresses of the service specified and shall be selected on the basis of a 60 degrees C ambient temperature.

Each bearing, except when otherwise noted, shall be rated in accordance with the latest revisions of AFBMA Methods of Evaluating Load Ratings of Ball and Roller Bearings for one of the following classes of B-10 rating life:

A. Class M1 8,000 hours of operation

B. Class M2 20,000 hours of operation

C. Class M3 50,000 hours of operation

D. Class M4 100,000 hours of operation

E. Class M5 200,000 hours of operation

Unless otherwise noted, all process-associated equipment, including motors, drivers and driven units shall have, as a minimum, bearings for Class M3 life.

All grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type designed for use with quick hydraulic couplings attached to grease guns. All equipment shall be equipped with an identical type of grease fittings, Alemite, Zerk, or equal.

Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and shall be equipped with a filler pipe and an external level indicator gauge. To avoid work hardening or "brinelling" damage from vibration, bearings shall be removed and shipped separately, or rotors shall be locked in place to prevent movement during transport.

2.10 GUARDS

All exposed moving parts shall be protected with guards in accordance with the requirements of the State Division of Safety Standards.

Belt guards shall be fabricated of 16 gauge, expanded metal or wire screen with 70 percent free area and steel frame, covered both sides. Provide visual inspection of moving parts and insertion of tachometer without removal of guard. Provide access door in guard to permit checking of belt tension. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts.

Shaft guards shall be solid 16 gauge galvanized steel, inverted "U" shape trough cover over entire length of exposed horizontal shafts, and tubular shape for vertical shafts. Extend cover to below bottom of shaft and couplings. Provide for lubrication of bearings without requiring removal of cover.

All equipment with exposed moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION - AUTOMATIC EQUIPMENT - MAY START AT ANY TIME". Signs shall be 10 inches by 14 inches in size and shall be constructed of corrosion-proof material with a heavy-duty porcelain enamel finish or 1/8" thick butyrate or fiberglass. Letters shall be white in a red oval on a black background. Signs shall be installed near exposed moving parts.

2.11 ELECTRIC MOTORS

A. <u>General</u>

1. Standards: Motors shall be built in accordance with IEEE Standards, NEMA Standard MGI, latest revision, and to the requirements specified herein. Where a conflict may exist, these specifications take precedence.

2. Type: Motors specified herein are three-phase squirrel cage for 1/2 HP and above; or single-phase types for less than 1/2 HP; or D.C. for D.C. Variable Speed Drives.

3. Rating: Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where detailed on the Electrical Drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.

   The motor shall not be required to deliver more than its rated nameplate horsepower, at unity (1.0) service factor, under any condition of mechanical or hydraulic loading.

   All motors shall be continuous time rated suitable for operation in a 40 degrees C ambient unless noted otherwise.

4. Specific motor data such as HP, Service Factor, RPM, enclosure type etc., is specified under the detailed specification for the mechanical equipment with which the motor is supplied.

B. Nameplates

The motor manufacturer's nameplates shall be engraved or stamped on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG1-10.38 or MG1-20.60, as applicable.

C. Submittal Data

Submittal of motor data for acceptance shall include complete nameplate data in accordance with NEMA Standards cited above and, in addition, the following for motors 3 hp or larger:

1. Ambient temperature rating.

2. Service factor.

3. Efficiency at 1/2, 3/4 and full load.

4. Power factor at 1/2, 3/4 and full load

5. Motor outline, dimensions and weight.

6. Descriptive bulletins, including full description of insulation system.

7. Bearing design data

8. Special features (i.e., space heaters, temperature detectors, etc.)

9. Wiring diagrams for motor power leads, over temperature switch, heater and moisture monitoring.

D. Condensation Heaters

Condensation heaters, where specified under the detailed mechanical specifications shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 V, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate. Power leads for heaters shall be brought out at the motor lead junction box.

E. Winding Temperature Detectors

Where specified under the detailed mechanical specifications for individual equipment or on all A.C. motors to be connected to a variable speed drive, there shall be a factory installed winding temperature detector consisting of 3 thermostats (1 per phase) wired in series, with leads terminating in the main conduit box. This device shall protect the motor against damage for overheating caused by single phase,overload, high ambient, abnormal voltage, locked rotor, frequent starts or ventilation failure. The protective device shall have normally closed contacts rated 120VAC, which opens on high motor temperature. Not less than two (2) sets of three (3) detectors shall be furnished with each motor requiring such detector with one left as a spare. Temperature detectors shall be TI Klixon 9700 series or equal.

F. Submersible Type1 Protection Devices

Where specified under the detailed mechanical specifications for individual equipment, furnish and install at the motor control center (unless indicated otherwise) a solid state device that provides a warning signal when the motor oil reaches a certain level of contamination by water. The contamination level is determined by measuring the resistivity of the motor oil bath. The resistivity shall be measured using a probe (di-electrode). The probe is connected to a lead, which runs back through the motor cables to the sensing device. The sensing device shall trip an auxiliary relay at low resistance (100K ohms or lower), to provide an alarm. The submersible Type 1 protection device shall be ABS Pumps Inc., Sealminder or equal.

G. Submersible Type 2 Protection Devices

Where specified under the detailed mechanical specifications for individual

equipment, furnish and install at the motor control center (unless indicated otherwise) a solid state protection device for monitoring the temperature and leakage detectors installed at the equipment. The solid state device shall operate on the current sensing principal whereby a change in temperature or leakage condition shall change the resistance of the associated sensor and thus alter the current in the sensing circuit. The protection device shall contain two sets of dry contacts, one for over temperature and one for leakage. The dry contacts will change state upon occurrence of an over temperature or leakage condition so as to shutoff the equipment on over temperature and provide an alarm for leakage. The submersible Type 2 protection device shall be Flygt, ITT Industries MiniCAS or equal.

H. Submersible Type 3 Protection Devices

1. Each pump shall be provided with its own self-contained control and status protection device module which shall be mounted within the motor control center (unless indicated otherwise). This module shall operate from a 24 VAC transformer furnished with module and shall provide a single point within the control system for pump sensor output processing. The protection device module shall have a manual reset so that the operator must locally restart the pump and thus be provided with local indication as to the cause of pump stoppage.

2. The protection device module shall interface for the direct connection of all pump/motor internal monitoring devices by furnishing the module with four (4) 24 VAC Relays for the following functions.

   a. Stator winding over temperature protection (stops pump, local LED indication).

   b. Stator leakage alarm (local LED indication and contacts for remote alarm indication).

   c. Lower bearing temperature protection (adjustable, stops pump, local LED indication).

3. The submersible Type 3 protection device shall be Flygt, ITT Industries, CAS or equal.

I. Single Phase Motors

1. General: Unless otherwise specified, motors smaller than 143T (1/2 hp) frame shall be single phase, capacitor start. Small fan motors may be split-phase or shaded pole type if such are standard for the equipment. Wound rotor or commutator type single-phase motors are not acceptable

unless their specific characteristics are necessary for the application.

2. Voltage: Motors shall be rated for operation at 115 volts, single phase, 60 Hz. Should unusual conditions require a three-phase motor on a frame smaller than 143T, it shall be designed for 200 volts, three phase, 60 Hz, but only after written approval has been received from the Engineer.

3. Enclosure: Motors shall be totally-enclosed in conformity with NEMA Standard MG1-10.35. Small fan motors may be open type if suitably protected from moisture, dripping water and lint accumulation.

   Locked rotor current shall not be greater than specified in NEMA Standard MG1-12.32, Design "N".

4. Bearings: Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.

J. Three Phase Motors - Frames 143T through 449T

1. General: All motors 1/2 HP and larger shall be on a NEMA frame 143T or larger. Motors shall be designed and connected for operation on a 240 or 480 volt, 3 phase, 60 hertz alternating current system, as applicable. Dual voltage (230/460) rated motors are acceptable.

2. All motors shall be NEMA Design B, normal starting torque unless noted otherwise, Starting KVA/HP (Locked rotor) shall not exceed the values given in NEMA Standard MG1-10.37. Motors shall be manufactured by US Motors, General Electric, Westinghouse, Reliance, or equal.

3. Bearings: Anti-friction motor bearings shall be designed to be re-greasable and initially shall be filled with grease suitable for ambient temperatures to 40 degrees C. Bearings shall be AFBMA Types BC or RN, heavy duty, or shall otherwise be shown to be suitable for the intended application in terms of B-10 rating life, Class M3 or better.

   All grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type as manufactured by the Alemite Division of the Stewart-Warner Corporation.

4. Insulation: Insulation systems shall be Class B or F (except as modified below) and shall be the manufacturer's premium grade, resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock.

5. Enclosures: Motors shall have a cast iron frame and cast iron or stamped steel conduit box. Conduit box shall be split from top to bottom and shall

be capable of being rotated to four positions. Synthetic rubber like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover. Motor leads shall be sealed with a non-wicking non-hygroscopic insulating material. A pad with drilled and tapped hole, not less than 1/4-inch diameter, shall be provided inside the conduit box for a motor frame grounding stud.

Motors weighing more than 50 pounds shall be equipped with at least one lifting lug. All hardware shall be corrosion resistant. Motors shall be delivered with manufacturer's standard paint.

The following specific features are required in addition to the preceding general specifications for the motor enclosures noted:

a. Open Drip Proof - Manufacturer's standard design with Class B insulation, stamped steel motor lead junction boxes and 1.15 service factor (@ 40 degrees C).

b. Totally Enclosed Fan Cooled - TEFC motors shall include Class B insulation, cast iron junction box, 1.15 service factor (@ 40 degrees C) tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger), upgraded insulation by additional dips and bakes to increase moisture resistance.

c. Explosion Proof - Explosion proof motors shall include Class B insulation, 1.15 service factor (@ 40 degrees C). Tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain/drain devices for frames 324T and larger), UL label for Class 1, Division 1, Group D Hazardous areas.

d. Severe Duty - Motors shall be of the corrosion resistant type conforming to motors designated by the manufacturer as "Chemical Duty", "Mill and Chemical", "Custom Severe Duty", or similar applicable manufacturer's quality designation. Severe duty motors shall include Class F insulation (applied at Class B rise), 1.15 service factor (@ 40 degrees C), tapped drain holes (corrosion resistant plug for frames 286T and smaller automatic breather/drain devices for frames 324T and larger), epoxy finish, upgraded insulation by additional dips and bakes to increase moisture resistance.

e. Submersible - Motors shall be housed in a watertight casing and shall have Class F insulated windings which shall be moisture resistant. Pump motors shall have cooling characteristics suitable to prevent continuous operation in a totally, partially, or non-

submerged condition continuously without overheating or other damage. The power cable shall be of adequate length to allow the unit to be wired as detailed on the electrical drawings without splices.

f. Inverter Duty – Motors shall be premium efficient design with inverter grade (Class H) insulation. Each inverter duty motor shall meet NEMA MG-1, Part 31 specifications for variable frequency drive (VFD) inverter duty applications. Motors shall be US Motors 841 Plus or equal.

g. Efficiency - Unless otherwise specifically specified for a specific motor, all motors shall be high-energy efficient type. Efficiencies shall be as determined in accordance with IEEE Standard 112 and NEMA MG-1-12.59. Motors shall be US Electric Motors "Premium Efficiency"; Baldor "Super-E", or equal.

2.12 ELECTRICAL DEVICES FURNISHED WITH MECHANICAL EQUIPMENT

A. Electrical Panels

1. Control panels supplied with mechanical equipment shall have the control switches, indicating lights, relay logic, and dry contact SCADA interfaces as indicated for each panel on the P&ID Drawings. Unless otherwise specified or shown all electrical power, control or instrumentation devices furnished as a "package" with mechanical equipment shall conform to the latest issue and addenda to the Joint Industry Council Electrical Standards for Mass Production Equipment (EMP-1-67), applicable NEMA Standards, National Electric Code (NEC 1999), or as modified herein.

2. Panels housing electrical equipment shall be NEMA rated for area into which panel is to be installed as shown on Contract Electrical Drawings. NEMA 4X panels shall be stainless steel. NEMA 1, 12 or 3R panels shall be galvanized steel, electrostatic applied baked enamel, painted gray. Panels located in Class 1 locations shall be explosion proof.

3. Devices mounted in non-ventilated panels shall be rated for a 50 degrees C (122 °F) ambient. Panels with devices rated less than 50 degrees C shall have ventilation fans and louvers. Louver openings shall have removable metal filters. All outdoor panels shall have heaters with guards and thermostat. Fans and heaters shall be powered from panel internal 120VAC control power.

4. A main panel power disconnect device to disconnect all power within the panel shall be an integral part of the panel and shall be one of the following types:

a. A horsepower rated heavy-duty fused safety switch or circuit breaker for 480, 240, or 208 volt, 1 phase or 3 phase panels. An outer door mounted operator for each switch or breaker padlockable in the off position shall be provided.

b. Circuit breaker for 120 volt, 1 phase panels.

5. Individual motor circuit protector (magnetic only circuit breaker) or fused protection shall be provided for each motor feed from panel.

6. All panels supplied with a 480-volt power feeder shall be provided with an integrally mounted dual winding 120-volt secondary control power transformers with primary and secondary fusing. Control power transformers shall have the neutral grounded.

7. All door mounted devices shall be of a heavy-duty industrial type quality. Lights, switches and pushbuttons shall be standard 30mm diameter, NEMA 13, U.L. listed and water & oil tight. All outer door mounted devices shall have black phenolic nameplates with 3/16" (minimum) white letters fastened by device assembly or stainless steel screws.

8. All indicating lights shall be full voltage 120VAC, LED type with push to test switch and wiring. Light lens colors shall be as follows:

a. Open/On Green

b. Closed/Off Red

c. Alarm/TroubleAmber

d. Power On White

9. Control relays shall be plug-in type with clear see-through sealed housing. Provide relay energized neon lamp or LED inside relay housing.

10. Time delay relays shall be solid state, plug in type with LED timer energized indicator lights.

11. All fuse shall have visible blown fuse indicator lights.

12. Contacts for external status, alarms or equipment interlocking shall be of the isolated contact type and provided as required per individual equipment specifications or Process and Instrumentation "P-Series" Drawings.

Contacts shall be rated 10 amps at 120VAC continuous pilot duty. Alarm contacts shall be of the maintained latching contact type, requiring manual reset. Reset pushbuttons shall be provided and located on outer door for latching alarms.

13. Motor starters shall be magnetic, 120VAC coil solenoid operated, NEMA rated for horsepower of supplied equipment, contactor type, with chatter-proof armatures. Each motor starter to have a normally open and a normally closed auxiliary contacts. Provide one bimetallic type thermal overload relay for each phase.
An outer door insulated mechanical reset mechanism shall be installed for each motor starter thermal overload reset.

14. Watertight gasketed conduit hubs shall be used for all conduit penetrations to outdoor panels. Conduit entries to outdoor panels shall not enter top of panels.

15. Auxiliary devices (pressure switches, flow switches, etc.) located remotely from panels but furnished under this Section shall have enclosures as specified in the individual mechanical sections, or in conformance with the NEMA area classification noted on Contract Electrical drawings.

16. Schematic (elementary) or connection wiring diagrams, and equipment material lists shall be furnished for all panels. For panels containing a complex control scheme, a written operational theory shall be cross-referenced to the schematic diagram. The wiring diagram in its "as built" form shall be fastened to the panel door when panel is delivered to jobsite. The equipment material list shall identify the actual manufacturer, manufacturer's part or model number and a cross-reference as to its location in the panel. Generic part or model numbers are not to be used in material lists.

B. Wiring

1. Conductors extending beyond a panel to other auxiliary equipment which is pre-wired on a skid type or package base shall be protected by galvanized rigid steel conduit. Where terminating at a motor or other similar device requiring frequent movement or which produces excessive vibration liquid tight type flexible conduit shall be used. Liquid tight conduit will be limited to three (3) feet maximum length at any termination. All pre-wired wiring shall be copper, #14 AWG minimum.

2. Input or output instrumentation level signals shall be 4-20 mA and provided as required per the individual equipment specification and Process & Instrumentation “P-Series” drawings. All signal wiring shall have copper twisted shield pairs with overall shield.

3. Separate power, control and instrumentation terminal strips shall be provided for all external panel connections. All terminal points shall have black machine printed identification numbers on white background.

4. All wires inside panels and on pre-wired packages and skids shall have wire labels at each end point. Wire labels shall be white shrink tubes with permanent ink black machine typed lettering.

2.13 PRESSURE GAUGES

Pressure gauges furnished with mechanical equipment shall be as specified in Section 15080.

2.14 TOOLS AND SPARE PARTS

A. All special tools required for exclusive operation and maintenance of respective items of equipment shall be furnished with those items of equipment by the manufacturer. This includes special tools, instruments, accessories required for proper "in-plant" adjustment, maintenance, overhaul, and operation. Tools shall be high-grade, smooth, forged, alloy tool steel.

B. All tools and spare parts shall be carefully packed in cartons, labeled with indelible markings, and shall be adequately treated for a long period of storage. Complete ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The tools and spare parts shall be delivered and stored in a location as directed.

C. Spare parts for certain equipment provided under Divisions 11, 15, 16 and 17 have been specified in the pertinent Sections of the Specifications. All spare parts shall be collected and stored in a designated area. In addition, an inventory listing all spare parts, the equipment they are associated with, the name and address of the supplier, and the delivered cost of each item shall be furnished. Copies of actual invoice for each item shall be furnished with inventory to substantiate the delivered.

2.15 LUBRICANTS

Provide all mechanical equipment with a sufficient supply of correct lubricant for starting, testing, and an initial 120-day operation period. All lubricants shall be of types recommended by the applicable equipment manufacturer. Subject to the approval of the equipment manufacturer's, lubricants shall be limited to the least number or types required for normal maintenance of all equipment. Not less than 90 days before the date scheduled for field testing of equipment three (3) copies of a listing indicating all lubricants for item of mechanical equipment shall be provided. Unless otherwise noted, all grease lubrication fittings shall be of an approved standard hydraulic type.

2.16 LIFTING LUGS

Lifting lugs shall be provided for all equipment weighing 50 pounds or more.

2.17 VIBRATION

A. This section specifies the maximum allowable vibration levels for all mechanical equipment. Additional requirements that may be more stringent may also be listed in individual equipment specifications. In that case, the more stringent of the two requirements shall apply. Testing of equipment at the factory and in the filed as identified in PART 3 of this specification shall demonstrate compliance with the specified vibration limits. All vibration tests shall be conducted under actual operating conditions:

1. Unfiltered readings at each unit shall have less than the following peak to peak amplitudes.

Operating Speed (revolutions per minute)	Centrifugal Blowers	Unfiltered (Overall) Peak-to-Peak Amplitude (mils)		
		Other Rotating Equipment	Non-Clog Mixed Flow Pumps	Clean Fluid Pumps
0 - 300	N/A	5.0	6.0	6.0
301 - 600	N/A	4.0	5.0	5.0
601 - 900	N/A	3.0	4.0	3.0
901 - 1,200	N/A	2.0	3.5	2.0
1,201 - 1,500	N/A	1.8	3.0	1.8
1,501 - 1,900	N/A	1.5	2.5	1.5
1,801 - 2,400	N/A	1.0	2.0	1.0
2,401 - 3,000	N/A	0.8	1.5	0.8
3,001 - 3,600	1.25	0.7	1.3	0.7
Above 3,600	1.0	0.6	1.2	0.6

2. Vibration Velocity Limits: Unless otherwise specified, equipment is not to exceed the following peak velocity limits:

Item	Unfiltered Overall Limit (inches per second)	Any Filtered Peak Limit (inches per second)
Non-Clog or Mixed Flow Pumps	0.35	0.25
Clean Fluid Pumps	0.25	0.20
Motors and Steady Bearings	0.25	0.20
Gear Reducers, Radial	Not to exceed AGMA 6000-A88 limits	
Other Reducers, Axial	0.10	0.10
Centrifugal Blowers	0.15	0.10

B. For all equipment, axial shaft vibration displacements (relative to casing) shall not exceed 50 percent of the maximum lateral shaft vibration displacements (relative to casing existing at any point along the shaft).

C. The above vibration responses are to include the range from 5.0 Hz to 5000 Hz and shall therefore encompass both low and high frequency responses of the subject equipment. The measurements shall be obtained with the equipment installed and operating at any capacity within the specified operating range. In addition to these maximum unfiltered readings, it is also stipulated that no narrow band spectral acceleration component, whether sub-rotational, higher harmonic or asynchronous multiple of running speed, shall exceed 40 percent of the synchronous displacement amplitude component without manufacturer's detailed verification of the origin and ultimate effect of said excitation.

Any equipment showing excessive vibration shall be corrected by the Contractor at his expense and the equipment retested.

D. The Contractor shall furnish a written report covering all the test values and data for each unit tested.

PART 3: EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Belt Driven Equipment: Mount with motors on common steel base with adjustable motor mount.

B. Pumps: Align pump and motor. Completely fill steel and cast iron pump bases with concrete grout after properly set.

C. Install equipment so nameplates are visible.

D. Basis for equipment and material installation is the published recommendations of manufacturer. Submit such recommendations for review.

E. Pipelines and other connections to mechanical equipment shall be installed square and shall not put in strain or use the equipment for support unless it is specifically designed for it.

3.02 IDENTIFICATION

A. Provide manufacturers' nameplates on all equipment, identifying manufacturer's name, model number, size, capacity, and electrical characteristics.

B. Leave all manufacturers' nameplates clean and legible. Install all equipment so view of nameplates is not obstructed.

C. Identify all equipment with symbol number and service as shown. Identification shall be on 1-1/4 inch by 3 inch, or larger nameplates, securely fastened to equipment.

D. Provide engraved identification of function on switches and manually operable controls.

3.03 CLEANING

A. During progress of work, keep premises reasonably free of debris, cuttings, and waste material. Upon completion of work, and at other times as directed, remove all such debris from premises.

B. Clean equipment and materials. Remove foreign materials including dirt, grease, splashed paint, and plaster. Restore to original condition any finish damaged.

3.04 FACTORY QUALITY CONTROL TESTING

A. All pumps and mechanical equipment shall receive the following minimum factory testing. Additional testing requirements may be specified in the individual equipment specification sections.

B. All pumps shall be provided with manufacturer’s standard factory quality control testing as modified herein.

1. All pumps greater than 5 horsepower shall receive a hydrostatic test of the pump casing at 1.5 times the pump shut off head.

2. All pumps shall be statically and dynamically balanced and shall have a certified balancing report.

3. All pumps 5 horsepower and above shall receive a standard manufacturer's bench test that shall include a minimum of 5 test points defining the pump curve. Test points shall correspond to the design points given in the individual pump specification. The remaining test points shall define the pump curve above and below the specified design conditions. In addition, pump shut off conditions shall also be tested. Test procedures shall follow appropriate sections of the Hydraulic Institute Standards in addition to the requirements in this and other Sections.

   As a minimum, pump head, flow, power, speed, efficiency and NPSH shall be determined and recorded.

4. All pumps scheduled to be driven by variable frequency drives shall be factory tested with a minimum of 5 test points at full speed and 5 test points at each speed specified under the design conditions in the individual pump specifications. If no alternate speed conditions are specified, 5 test points shall be provided at the minimum operating speed of the pump as recommended by the Manufacturer.

5. Vertical turbine pumps shall have bowl tests only.

6. Pump Test Tolerances: In accordance with appropriate Hydraulic Institute Standards, except the following modified tolerances apply:

   a. From 0 to plus 5 percent of head at the rated design point flow.

   b. 0 to plus 5 percent of flow at the rated design point head.

   c. No negative tolerance for the efficiency at the rated design point.

   d. No positive tolerance for vibration limits. Vibration limits in Hydraulic Institute Standards do not apply, use limits specified in this Section of the Specifications.

7. All non-submersible pumps greater than 10 horsepower shall also be tested for vibration in each plane at each exposed bearing location, on the pump, and on the motor. Vibration limits shall meet the requirements specified in Section 2.17 or more stringent requirements if specified in the individual equipment specifications.

8. All non-submersible pumps and non-vertical turbine pumps greater than 15 horsepower shall also receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height. Pump and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications.

9. For all pumps except vertical turbine pumps, the actual job motor shall be used unless an alternate means of driving the equipment is agreed to by the Engineer prior to testing.

C. All mechanical equipment shall be provided with the manufacturer's standard factory quality control tests, which shall clearly demonstrate conformance with the specifications and the specified manufactured equipment is free from defects. Standard tests shall be as modified herein.

1. All blowers and Fans over 10 horsepower shall receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height. Blower and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications.

2. All other rotating equipment greater than 40 horsepower shall be tested for vibration in each plane at each exposed bearing location, on the blower, and on the motor. Vibration limits shall meet the requirements specified in Section 2.17 or more stringent requirements if specified in the individual equipment specifications.

3. All other rotating equipment greater than 40 horsepower shall receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height. Blower and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications.

4. For all mechanical equipment, the actual job motor shall be used unless an alternate means of driving the equipment is agreed to by the Engineer prior to testing.

D. Test Witnessing: Factory tests shall be non-witnessed unless specified in the individual equipment specifications. When factory tests are indicated as witnessed, the costs for witnessing the tests by the Engineer, travel, and lodging costs shall be born by the Owner for the first test. All such costs for any subsequent factory re-testing required shall be born by the Contractor. The Contractor shall notify the Owner in writing a minimum of 21 calendar days prior to commencement of witnessed factory tests.

E. Reports: Submit reports for Factory testing. Report features:

1. Report results in a bound document in generally accepted engineering format with title page, written summary of results compared to specified requirements, and appropriate curves or plots of significant variables in English units.

2. Include appendix with a copy of raw, unmodified test data sheets indicating test value, date and time of reading, and initials of person taking the data.

3. Include appendix with sample calculations for adjustments to raw test data and for calculated results.

4. Include appendix with the make, model and last calibration date of instrumentation used for test measurements.

5. Include in body of report a drawing or sketch of the test system layout showing location and orientation of the test instruments relative to the tested equipment features.

3.05 FIELD QUALITY CONTROL TESTING

A. Temporary Facilities and Labor: Provide all necessary fluids, utilities, temporary piping, temporary supports, temporary access platforms or access means and other temporary facilities and labor necessary to safely operate the equipment and accomplish the specified testing. With Owner's permission, some utilities may be provided by fully tested permanently installed utilities that are part of the Work.

B. Instrumentation: Provide all necessary test instrumentation, which has been calibrated within one year from date of test to recognized test standards traceable to the National Institute of Standards and Technology, Washington, D.C. or approved source. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for Field Quality Control Tests.

C. Field Quality Control Tests: Schedule test date and notify Engineer at least 7 days prior to start of test. Test Measurement and Result Accuracy:

D. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments.

Do not adjust results of tests for instrumentation accuracy. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

E. Field Testing

1. All pumps and mechanical equipment shall receive the following minimum field testing. Additional field testing requirements may be specified in the individual equipment specification sections.

2. Submit test plan indicating test start time and duration, equipment to be tested, other equipment involved or required; temporary facilities required, number and skill or trade of personnel involved; safety issues and planned safety contingencies; anticipated effect on Owner's existing equipment and other information relevant to the test.

3. Perform general start-up and testing procedures for the equipment as recommended by the Manufacturer's written start up instructions.

4. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested and that the manufacturer's representative has certified proper installation of the equipment.

5. All mechanical pumps and equipment shall be given a 7-day operational test. Equipment shall be operated continuously under normal operation as intended by the Contract Documents. Operational testing shall include automatic control and instrumentation systems. Any equipment or control systems that fail to perform properly shall be corrected and retested by the Contractor. Upon completion of a satisfactory operational test, a certificate of completion shall be prepared and signed by the Owner.

6. In addition to an operational test, certain mechanical equipment and pumps shall be given a field performance test as specified herein to demonstrate the complete system as installed meets the specified performance requirements.

7. All operational and performance testing shall be completed and accepted prior to acceptance of the equipment by the Owner. Equipment warranty periods shall not begin until final acceptance of the equipment by the Owner.

F. Field Performance Tests for Pumps

1. All pumps shall be provided with a field performance test in accordance with applicable Hydraulic Institute Standards in addition to the requirements in this and other Sections.

2. All pumps 5 horsepower and smaller shall receive a field test that shall include testing the pump at the specified design condition. Pump Flow, head, and horsepower shall be recorded.

1. All pumps greater than 5 horsepower shall receive a field test that shall

include a minimum of 5 test points defining the pump curve. Test points shall correspond to the design points given in the individual pump specification. The remaining test points shall define the pump curve above and below the specified design conditions. In addition, pump shut off conditions shall also be tested. Test procedures shall follow appropriate sections of the Hydraulic Institute Standards in addition to the requirements in this and other Sections. As a minimum, pump head, flow, power, speed, efficiency and NPSH shall be determined and recorded.

3. All pumps scheduled to be driven by variable frequency drives shall be tested with a minimum of 5 test points at full speed and 5 test points at each speed specified under the design conditions in the individual pump specifications. If no alternate speed conditions are specified, 5 test points shall be provided at the minimum operating speed of the pump as recommended by the Manufacturer.

4. Vertical turbine pumps shall be tested as a complete system after assembly.

5. Pump Test Tolerances: In accordance with appropriate Hydraulic Institute Standards, except the following modified tolerances apply:

   a. From 0 to plus 5 percent of head at the rated design point flow.

   b. 0 to plus 5 percent of flow at the rated design point head.

   c. No negative tolerance for the efficiency at the rated design point.

   d. No positive tolerance for vibration limits. Vibration limits and test methods in Hydraulic Institute Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

6. All non-submersible pumps greater than 10 horsepower shall also be tested for vibration in each plane at each exposed bearing location, on the pump, and on the motor. Vibration limits shall meet the requirements specified in Section 2.17 or more stringent requirements if specified in the individual equipment specifications.

7. All non-submersible pumps greater than 15 horsepower shall also receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height. Pump and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications.

8. For all pumps, the actual job motor or driver shall be used.

G. Field Performance Test for Mechanical Equipment: All mechanical equipment

shall be provided with a field performance tests.

1. Test all mechanical equipment at rated design conditions. Record equipment horsepower, speed, and other process performance parameters. Demonstrate compliance with the specified design conditions.

2. All equipment over 25 horsepower shall also be tested for vibration in each plane at each exposed bearing location, on the machine, and on the motor. Vibration limits shall meet the requirements specified in Section 2.17 or more stringent requirements if specified in the individual equipment specifications.

3. All blowers and Fans over 2 horsepower and all other equipment over 25 horsepower shall receive a noise test. Measure the unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment on four sides at the mid point of the equipment height. Blower and driver shall not exceed 85 dBA or lower noise level if specified in the individual equipment specifications.

4. For all mechanical equipment, the actual job motor or driver shall be used.

H. Reports: Submit reports for field performance testing. Report features:

1. Report results in a bound document in generally accepted engineering format with title page, written summary of results compared to specified requirements, and appropriate curves or plots of significant variables in English units.

2. Include appendix with a copy of raw, unmodified test data sheets indicating test value, date and time of reading, and initials of person taking the data.

3. Include appendix with sample calculations for adjustments to raw test data and for calculated results.

4. Include appendix with the make, model and last calibration date of instrumentation used for test measurements.

5. Include in body of report a drawing or sketch of the test system layout showing location and orientation of the test instruments relative to the tested equipment features.

3.06 PRELIMINARY OPERATION

Operate any portion of installation if requested. Such operation does not constitute acceptance of the work as complete.

3.07 STARTUP SERVICE

A. Prior to startup, check auxiliary connections, lubrication, venting, controls, wiring, equipment for proper rotation, and install and properly set relief and safety valves to insure readiness of systems.

B. Start and operate all systems. All mechanical equipment and systems shall be placed in service by qualified factory authorized technicians who shall provide a written statement that the equipment has been installed and placed in service as recommended by the manufacturer. If, in the opinion of the Engineer, a start-up technician is not qualified or competent to work on a particular piece of equipment, the Contractor shall replace that person with one who is qualified and competent.

END OF SECTION

SECTION 11302

SUBMERSIBLE SEWAGE PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

The work of this section consists of furnishing and installing submersible sewage pumps at the pump station. Pump requirements are as described herein.

1.02 EQUIPMENT NUMBERS

A. PMP 1011 Will S Green Pump 1

B. PMP 1012 Will S Green Pump 2

C. PMP 1013 Will S Green Pump 3

D. PMP 1014 Will S Green Pump 4

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 01610: Seismic Anchorage and Bracing

C. Section 01611: Seismic Design Requirements

D. Section 09900: Painting

E. Section 11010: General Mechanical Equipment Provisions

F. Division 16: Electrical

1.04 SUBMITTALS

A. In accordance with Section 01300.

B. Submit data regarding pump and motor characteristics and performance. The data shall include certified pump performance curves, which show that the units meet the specified requirements for head, capacity, efficiency, and horsepower for the capacities specified.

C. All pumps and appurtenance in this section shall be submitted in a complete initial submittal.

D. Submit certified factory performance test results.

E. Manuals: Furnish manufacturer's installation, lubrication, operation, and maintenance manuals, bulletins, and spare parts list.

1.05 QUALITY ASSURANCE

A. Require manufacturer to furnish and coordinate pump, motor, discharge elbow, guide rails, guide rail supports and all brackets and accessories for complete and working submersible sewage pump systems as specified and shown in the drawings.

B. Alternative pumping systems furnished shall be of a design that has been used in at least five (5) similar applications for a minimum of five (5) years with satisfactory performance.

C. Pump and hatch coordination: See section 2.10 of this specification.

D. Performance Testing:

The pump manufacturer shall perform the following inspections and test on each pump before shipment from factory:

1. Impeller, motor rating and electrical connections shall first be checked for compliance with these specifications.

2. A motor and cable insulation test for moisture content or insulation defects shall be made.

3. Prior to submergence, the pump shall be run dry to stablish correct rotation and mechanical integrity.

4. The pump shall be run for 30 minutes submerged, a minimum of six (6) feet under water.

5. After operational test 4, the insulation test 2 is to be performed again.

1.06 PERFORMANCE GUARANTY

In addition to the 5-year warranty against defects in workmanship and materials described in Article 3.03, the manufacturer shall provide a 1-year written guaranty that each pump shall be capable of meeting or exceeding the performance requirements for all the conditions in this specification, including operating continuously under partially submerged conditions (where motor is not submerged) when specified. Performance failure shall include repeated high motor temperature alarms caused by problems with the motor cooling system. The guaranty shall require that if any pump fails to perform, the manufacturer shall remove the pump and reimburse the Owner for the cost paid to the Contractor for furnishing and installing the pump.

PART 2 - MATERIALS

2.01 GENERAL

Pumps shall be capable of handling raw sewage. The pumps shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of upper deck to the discharge connection. There shall be no need for personnel to enter the wet well.

Contractor is responsible for supplying the pumps and motors, discharge elbows, rails, power cables and all other appurtenances, as specified herein.

2.02 DESIGN CRITERIA

A. All (4) Pumps:

Pumps shall be Concertor 6020 XPC N100; or equal. The pump motor shall be variable frequency drive (VFD). Pumped material shall be raw sewage.

Minimum Motor Size	10 HP
Motor Conditions	460V, 2154 RPM, 3 Phase
Drive Type	Variable Frequency (VFD)
Discharge Size	4-inches
Design Points	340 gpm @ 28 feet TDH
	740 gpm @ 32 feet TDH

2.03 MATERIALS

A. The pump and motor package shall be Factory Mutual approved Class I, Division I, Group C & D service, or equivalent UL listed.

B. Casing shall be ASTM A48, Class 35B or 40B, and sized according to Drawings. The pump volute shall be a single piece grey cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The pumps shall be of the submersible type with an integral motor and pumping unit. The volute shall have an adjustable bottom plate. The bottom plate shall be cast with grooves threading outward from the center opening of the plate to the outer diameter. The pump(s) shall have a semi-open impeller capable of handling solids laden fluids without clogging. The suction inlet shall have a wave form with the leading edge of the impeller overlapping the wave form. Should a textile or

plastic sheet plug the inlet, The shearing action of the leading edge of the impeller against the wave form of the inlet will cut away enough of the material to clear the inlet.

C. Pump and motor shaft shall be of stainless steel and shall be completely isolated from the pump liquid.

D. Impeller: The impeller shall be of hard-iron and meet the physical and tensile strength requirements of ASTM A48, Class 35B.

2.04 BEARINGS

A. Pump bearings shall be of the ball or roller type. The motor pump shaft shall be supported by two permanently grease lubricated ball bearings. External bearing lubrication ports, which allow bearing contamination and over-packing, will not be allowed.

B. The upper bearing shall be single roller bearing, the lower bearing shall be a two row angular contact bearing or taper roller to compensate for axial thrust and radial forces.

C. Pump bearings shall be of the anti-friction type designed to give 50,000 to 100,000 hours life by the L-10 calculations at maximum speed and operating load in continuous operations.

D. Anti-friction bearings which are lubricated shall be protected in accordance with the bearing manufacturer's recommendations against the formation of rust during a period of storage while awaiting the completion of installation and startup.

2.05 MECHANICAL SEALS

A. The shaft shall be sealed by a tandem mechanical shaft seal system consisting of two seals, each having an independent spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counterclockwise direction of rotation without damage or loss of seal function.

B. Where a seal cavity is present in the seal chamber, 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.

2.06 FASTENERS

All nuts and bolts shall be Type 316 or 304 stainless steel.

2.07 IMMERSIBLE MOTORS

Pump motor shall be housed in a watertight airfilled, dryshell casing of NEMA B design and shall have Class H insulated windings, which shall be moisture resistant and rated for 155^{o}C. Premium efficiency IE3 motors in accordance with IEC60034-30. The motor shall

be air-filled and shall have Class “F” insulation. The rotor and stator shall be enclosed in a cast iron outer housing. Bi-metallic thermal switches shall be imbedded in each phase of the winding to sense high temperature. The rating of the switch shall be 130°C +/- 5°C. The control circuit shall be connected through the bi-metallic switches so the motor is shut down should a high temperature condition exist. The switches shall be self-resetting when the motor cools. Power cable shall be UL and CSA approved. -filled, dry-shell casing of NEMA B design and shall have Class H insulated windings, which shall be moisture resistant and rated for 155

2.08 MOTOR PROTECTION

A. Provide Type 3 protection devices in accordance with Section 11010 for 50 horsepower and larger.

B. Provide Type 2 protection devices in accordance with Section 11010 for all motor less 50 horsepower.

2.09 PUMP DISCHARGE ELBOWS

A. Elbows shall be permanently installed in the wet well, bolted to the concrete floor. They shall be designed to receive the pump connecting flange automatically when the pump is lowered into place, without the need of any bolts, gaskets, or nuts. There shall be no need for personnel to enter pump well.

B. Sealing of the pumping unit to the discharge connection shall be metal to metal and accomplished by a simple linear downward motion of the pump along the guide rails with the entire weights of the pumping unit pressing tightly against the discharge connection; no portion of the pump shall bear directly on the floor of the wet well and no rotary motion of the pump shall be required for sealing. Maximum leakage allowable to be less than l/2% of total flow at design point. Sealing of the discharge interface by means of a diaphragm, O-ring, or other devices will not be acceptable.

2.10 HATCHES

A. See Drawings and Specification section 8310.

2.11 GUIDE BARS AND BRACKETS

A. Two guide bars shall be provided for guiding the pump unit in raising and lowering. The guide bars shall not support any portion of the weight of the pump. The lower guide bar holders shall be integral with the discharge elbow.

B. Guide bars shall be sized according to the drawings, or if not shown, according to pump manufacturer’s recommendations, Guide bars shall be constructed of Schedule 40 stainless steel pipe, cut to the required length. Brackets shall be stainless steel.

2.12 PUMP LIFTING SYSTEM

A. All submersible pumps shall be supplied with a lifting system to allow the pumps to be removed for servicing in one continuous lift using boom truck hoist.

B. Each system shall consist of a length of stainless steel chain equal to the length of the guide bars plus 20 feet. All shackles and miscellaneous hardware shall be stainless steel.

2.13 SAFETY CABLE HOOKS

Hooks shall be stainless steel attached to the access hatch frame or concrete for connection of pump and mixer lifting lines.

2.14 CABLE HOLDER

Stainless steel cable holder shall be designed for bolting to the access hatch frame or concrete and capable of attaching the power cable strain grip and the liquid level control cables.

2.15 TOOLS AND SPARE PARTS

Tools and Spare Parts: All special tools required for normal operation and maintenance shall be furnished with the equipment. One spare pump shall be furnished.

PART 3 - EXECUTION

3.01 INSTALLATION OF EQUIPMENT

A. Install pumps and guide rail systems in accordance with manufacturer's recommendations and as shown on the Drawings.

B. The pump cable end will be sealed with a high quality protective covering to make it impervious to moisture or water seepage prior to electrical installation.

3.02 PROTECTIVE COATING

The submersible pumps shall be factory coated with a painting system equal to that specified in Section 09900.

3.03 WARRANTY

The submersible pumps and motors shall be provided with a warranty against defects in workmanship and materials and shall cover factory labor and parts for a duration not less than five (5) years.

3.04 FIELD TESTS

A. After installation of the pumping equipment and when water is available, each unit shall be given a running test during which it shall demonstrate its ability to operate without vibration or overheating and to pump satisfactorily. During the tests, observations shall be made of head, capacity, and motor input to detect any defects in the equipment at least three point on the pump curve. All defects or defective equipment revealed by or noted during the test shall be corrected or replaced promptly at the expense of the Contractor, and if necessary, the test shall

be repeated until satisfactory results are obtained. The Contractor shall furnish all labor, piping, equipment, and materials necessary for conducting the tests. Methods of determining head, flow, and power consumption shall be subject to approval by the Engineer.

B. All adjustments necessary to place the equipment in satisfactory working order shall be made at the time of the above tests.

C. In case the Contractor is unable to demonstrate to the satisfaction of the Engineer that the units will satisfactorily perform the service required and that they will operate free from vibration and heating, the unit may be rejected. The Contractor shall then remove and replace or modify the equipment at no additional expense to the Owner.

3.05 FACTORY TEST

Non-witness factory performance test shall be conducted on each pump and shall comply with specification Section 11010. Results shall be furnished to the Engineer for review and approval prior to shipment of equipment.

END OF SECTION

SECTION 11351

RECYCLED WATER BOOSTER PUMP STATION

PART 1 - GENERAL

1.1 DESCRIPTION

The work of this section consists of the furnishing and delivery of materials, equipment, and appurtenances for a packaged recycled water booster pumping system.

1.2 REFERENCE STANDARDS

The work of this section is subject to the requirements of applicable portions of the following standards:

A. NEMA – National Electrical Manufacturers Association

B. NEC – National Electrical Code

C. UL – Underwriters Laboratories, Inc.

D. AWWA – American Water Works Association

E. ANSI – American National Standards Institute

F. ANSI/HI – American National Standards Institute/Hydraulic Institute

G. ASTM – American Society of Testing & Materials

1.3 SUBMITTALS

Submittals shall be well organized, labeled, and presented in a professional manner in accordance with Section 01300. The pump station manufacturer shall submit the following items as part of a complete submittal package:

A. Shop Drawings, including 3D models of the proposed pump station. The manufacturer shall also provide digital models that can be viewable from any angle.

B. Electrical Schematics

C. Control Panel Layout Drawing

D. Manufacturers complete packaged pump system UL category QCZJ file number.

E. Technical data sheets for all major system components, including:

a) Pump performance curves and datasheets

b) Control Panel Components: VFD, PLC, Touchscreen Interface, Panel Enclosure, & UL 508A Certification
c) Powder Coating Data
d) Galvanizing Data
e) Valves
f) Instrumentation

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Precision pumping systems packaged pressure booster system, or equal.

2.2 VARIABLE SPEED PACKAGED PUMPING SYSTEM

A. Furnish and install a pre-fabricated and tested variable speed packaged pumping system to maintain constant water delivery pressure.

B. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed, built, and tested by the same manufacturer.

C. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards.

2.3 PUMPS AND MOTORS

A. Horizontally mounted, single stage, end-suction centrifugal pumps shall be designed for continuous operating service and shall have a continuously rising performance curve. The pump(s) shall meet the design criteria on the technical drawings.

B. Pumps furnished under this section shall be NSF/ANSI 61 approved for potable water applications.

C. Pumps shall be manufactured by Ebara Pumps or approved equal.

D. The booster skid shall include three (3) vertical in-line pumps (2 duty, 1 standby) and one (1) jockey pump. When both duty pumps are running the skid system shall provide a minimum flow of 1200 gpm @ 65 psi.

E. Motors shall be rated for operation at 208-240/480 VAC, 3 phase, 60 hertz, and service factor of 1.15 or greater.

F. Duty Pump Motors shall be 3,600 RPM maximum.

G. The motor shall be of proper size to drive the pump at any point on the operation curve without exceeding the percent of the motor horsepower nameplate rating.

H. Pump Construction:

a) Impeller: Pump impellers shall be constructed of bronze, fully machined on all exterior surfaces, and statically balanced.

b) Seal: Shaft seal shall be a mechanical seal with NI-resist stationary seat, carbon washer, Buna rubber flexible members, and 18-8 stainless steel metal parts and spring.

c) Motors: Motors shall be a standard TEFC IP55 NEMA type, induction style, premium efficient, and inverter duty suitable for variable speed operations per NEMA MG1 Part 31.4.4.2.

d) Motor frame: Steel or cast iron, aluminum shall not be permitted

e) Pump Casing: Close grain cast iron with replaceable wear ring

2.4 VARIABLE FREQUENCY DRIVES (PANEL MOUNT)

A. Provide a dedicated VFD for the jockey pump and a Main VFD to be alternated between the duty pumps. The duty pump VFD shall be automatically alternated between duty pumps based on pump starts, run-time, and faults.

B. Variable Frequency Drive(s) shall be mounted inside the control panel enclosure, with each VFD isolated from main input power by use of a contactor to protect the VFD from power outside of tolerances.

C. The variable frequency drive shall be IGBT based with selectable carrier frequency up to 15 KHZ. The VFD shall include terminals for incoming power, motor output power and control terminals. All VFDs shall include an RS485 port built-in to the VFD for dedicated communication to the PLC.

D. The VFD shall generate a sine-coded, variable voltage/ frequency, three phase output for optimum speed control. The VFD shall incorporate power loss ride-through for a minimum of 2 seconds. VFD protective features shall include current limit, auto restart, short circuit protection, electronic motor overload protection, and ground fault protection. The VFD shall have a push button programming display for easy access to operation parameters. The VFD shall be protected on the primary side by a breaker of the appropriate amperage.

a) Overload capacity: 120% rated output current for one minute.

b) Voltage fluctuation: +10%, -15%.

c) Sine wave, PWM, with full range, and automatic torque boost.

d) Frequency control range: 0 to 500 Hz.

e) Frequency accuracy: digital, 0.01 Hz, analog, .1%. Motor overload protection, instantaneous over current of 180% of rated output current.

f) Over voltage at 820vdc if 460v input.

g) Under voltage shall be user adjustable.

h) Momentary power loss: up to 2 second ride through.

i) Electronic ground fault.

j) Led capacitor charge indicator.

k) Input phase loss alarm.

l) Ambient temperature range of 0 to 40 degrees c.

a. Humidity of 95% non- condensing allowed.

E. Manufacturer: ABB ACQ580 Series with ISO 9001 certification or pre-approved equal.

F. DOL Motor Starting Equipment

2.5 The pump station motor controller shall include interlocking contactors to automatically energize/de-energize the lag-designated duty pump motor. Direct online starting equipment shall be an industrial motor starter unit with contactor and thermal-overload protection breaker.

2.6 PUMP SYSTEM CONTROLLER

A. General Requirements

a) Non-Proprietary, Open-Source Programming

b) To better facilitate owner access to system servicing, the control system shall be non-proprietary and open source. Proprietary control systems shall not be accepted.

c) Dual Language HMI Interface

d) To ensure that the control system warnings and parameters can be safely understood by a wide range of operators, the interface shall have a user-selectable English or Spanish Interface.

e) Controller User Guide

f) The pump station manufacturer shall supply an owner's manual in digital form that includes graphic images of all touch screens, complete with explanations of all settings and modes.

B. Programmable Logic Controller (PLC)

a) PLC shall consist of a central processor with built-in dual port Ethernet and USB connection. Processor shall be capable of expanding up to 4 I/O expansion modules and include the following features:

a. High-speed counter with 100 kHz maximum input frequency
b. Pulse output with 100 kHz maximum output frequency
c. Supply Power shall be 24V DC with maximum 35A maximum inrush current.
d. Environmental Ratings
1) Class 1, Division 2 Hazardous Location
2) Operating Temperature: -25 to 65 degrees Celsius
3) 10 – 95% Relative Humidity
e. Program Storage
1) Serial Flash Memory using embedded SD Card Slot
2) RAM Backup via lithium battery capable with up to 4 years battery life.
f. Communications Interface
1) 1-USB Mini-B USB Standard 2.0
2) 2 Ethernet Ports with RJ45 Connector
3) Protocols
a) Modbus TCP
b) Modbus RTU
c) Ethernet/IP
d) Bacnet
g. Manufacturer/Series
1) IDEC MicroSmart FC6A Plus or approved equal.

C. Operator Interface

a) General Requirements

a. The touchscreen shall allow operator access to all system settings and monitoring data.
b. The operator interface shall be a Color TFT LCD touchscreen
c. The touchscreen shall be mounted to the motor control panel door.
d. A VFD control keypad is not an acceptable substitution for the digital operator interface.
e. The operator interface shall allow the user to adjust the system parameters & settings to the PLC program locally without requiring any additional equipment such as a laptop computer.

f. System must be capable of programming VFD's via touchscreen (for 3-phase systems only)

D. Hardware Features

a. High Resolution Display with 640 x 480 pixels, with a minimum screen diagonal length of 10.4″.

b. Backlight with 100,000 hours

c. Supply Power shall be 24V DC with maximum 30A maximum inrush current.

d. Environmental Ratings

1) NEMA 4X

2) Class 1, Division 2 Hazardous Location

3) Operating Temperature: -20 to 60 degrees Celsius

4) 10 to 90% Relative Humidity, non-condensing

e. Communications Interface:

1) 1 Mini-B USB Standard 2.0

2) 1 Ethernet Port with RJ-45 Connector

3) RS232C or RS485

f. Program Memory Storage

1) 2GB SD Memory Card

E. Manufacturer/Series: IDEC High Performance Series or Pre-Approved Equal.

2.7 MONITORING FUNCTIONS

A. System Dashboard

a) Pressure, flow, and level status.

b) Pump status, including lead pump designation, VFD frequency, torque, kw and current draw.

c) Alarm conditions, with the ability to manually reset alarms.

d) Current values of all system sensors, including pressure and flow.

e) User selectable language icon.

B. Fault Log

a) The controller shall have a system fault log that displays the precise times of fault occurrences and recoveries, as well as message indicating the fault type. The fault log shall include a fault diagnosis utility that provides possible causes of and solutions to all system faults and warnings.

C. Trend Log

a) Trend graphing screen capable of detailing pressure, flow, and current data. Graphing function shall give the option to graph and plot a point at user adjustable intervals. All data shall be capable of being downloaded to a USB drive and accessible over Ethernet through FTP server. Trend log shall be .csv format.

    a. Advance I/O diagnostics
    b. HMI display must include utility screen that displays the current status of all digital and analog inputs/outputs, including device tag name (i.e. pump #1 auto). This function must be accomplished without opening the control panel.

D. Control Functions

a) The LCD color touchscreen must be capable of alternating between English and Spanish during operation by an end-user accessible button located within an operator screen. The system diagnostic utility must be capable of being displayed in both English and Spanish.

b) Control system must be capable of adding industry standard components without program modifications. Including but not limited to:

    a. Additional main pumps up to four
    b. Fill devices (valve/pump)
    c. High level float
    d. Master valve
    e. Additional filters
    f. Rain sensor

E. Pressure Settings

a) Pressure transmitter calibration, discharge pressure setpoint, and high/low pressure alarm/fault conditions.

F. Flow Settings

a) Low and high flow alarm conditions, flow meter sensor calibration settings, and total gallons pumped with user reset button and time/date stamp of last reset. In addition, a non-resettable flow totalizer.

G. Level Settings

a) Low- and high-level alarm conditions, level transmitter calibration settings, and level-based pressure setpoint manipulation.

H. Pump Settings

a) Pump detail screens showing total run hours of each pump since last reset and any modes, options, or functions specific to that pump. Must include troubleshooting utility as a visual display of pump permissive.

I. Automatic Filter Controls

a) Shall include two user selectable automatic flush modes - 1) Pressure Differential and 2) Timed Interval. System shall also include a manual flush capability.

2.8 REMOTE START/STOP SIGNAL RELAY

A. The PLC shall be able to start and stop the system based on a remote signal relay.

2.9 PRE-PROGRAMMED START-UP ROUTINES

A. The PLC shall be programmed with various start-up routines that limit and/or delay the starting and acceleration of the pump—ensuring that excessive velocity and pressure do not damage the distribution system.

B. The program shall include individual routines for initial start-up, mainline fill, re-start after a power outage, and re-start after a system fault.

C. The operator shall be able to adjust the timing of the routines via the operator interface.

2.10 PASSWORD PROTECTION

A. Unique user selectable password.

2.11 LOADING AND SAVING SYSTEM DEFAULT SETTINGS

A. The system shall allow the operator to Load Factory Default PLC settings, Save New Operator settings, and Load previously saved Operator PLC settings.

B. The PLC shall allow the operator to change the system date and time.

2.12 SCHEDULER

A. 7 day per week scheduler.

B. Multiple run times per day and speed/flow rate.

C. User assignable device scheduler consisting of 3 unique daily schedules for each applicable device.

D. Devices included but not limited to:

a) Main pumps

b) Jockey/PM pump
c) Fill pump
d) Master valve
e) Fill valve

E. System Protections

a) Controls shall shut down the pump station in the event of the alarm conditions described in this section, as well as otherwise indicated. The system controls shall attempt to restart the system after alarm shutdown or loss of power. After a user-adjustable number of attempts to re-pressurize the system, the controls shall go into hard shut down and remain so until manually reset.
b) Low Flow Shutdown. The PLC shall automatically shut down the system if there is no, or too little flow, based on signals received from a flow switch. The low flow shutdown shall have a user adjustable time delay.
c) Low Level Shutdown. The controller shall automatically shut-down the system based on low level signals from a level transmitter.
d) High Pressure Shutdown. In addition to the pressure data received from the pressure transmitter, the PLC shall automatically shut-down the system based on signals from a high-pressure switch.
e) Electrical Fault Shutdowns. Incoming power high, low, and imbalance limits. Shut-down and restart time delays shall be user-adjustable.
f) Analog Transmitter Failure. Input levels of all connected transmitters and meters shall be monitored for failures.
g) Motor starter failure. Circuit breaker and/or motor overload contacts shall be monitored to indicate a motor failure.

F. Communications

a) Web-Based Remote Monitoring and Control
    a. The pump stat ion control panel shall include a web-based remote control and monitoring system.
    b. Remote Monitoring must be capable of alternating between English and Spanish during operation by an end-user.
    c. Remote monitoring and control system shall be non-proprietary and not require a 3rd Party Application.
    d. The pump station shall be capable of being remotely monitored from any device with a web browser, such as a PC, tablet, or smart phone.
    e. Monitoring of pump station shall be seamless to the user via a web browser that shall be started by simply clicking on a hyperlink. Software shall not be required to be installed or configured on the user's computer.

f. The web page shall include full graphical representation of the pump station and its features and shall be capable of remotely changing all operating parameters of the pump station.

g. The pump station shall automatically send email or text alerts regarding warnings and faults and specify the station and specific fault/alarm.

h. The pump station manufacturer shall supply all required communication hardware except computer and computer accessories, including all necessary direct burial cable and antennas.

i. A cellular modem shall be mounted and wired inside control panel enclosure.

j. The connection shall be capable of communicating to the pump station over cellular modem, high speed Ethernet, or fiber optic cable.

b) Flow Signal Sharing

a. The control panel shall include an optical isolator to share the flow meter signal with a separate controller.

2.13 SCADA INTEGRATION

A. Control system must be provided with separate isolated network with user adjustable network settings from HMI. Future/optional equipment or updates must not be required for integration.

B. Must support communication protocols simultaneously.

C. Ethernet/IP

D. Modbus TCP

a) Must have instructions for communication map on HMI including device name, scaling units, format, and associated address (i.e., discharge pressure, xxx.x PSI, UINT – Modbus address xxxxx).

2.14 FACTORY TESTING

A. The pump station manufacturer shall conduct and document a complete factory dynamic test of the pump station prior to shipment. Pump station shall be tested throughout the entire operating range at the net discharge pressure called for in the technical specifications. Individual pump pressure, flow, RPMs, volts, amps, KW, and power factor shall be documented for verification by the Owners' Representative prior to delivery upon request.

B. Hydrostatic Testing. The packaged pump station shall undergo hydrostatic testing that meets ANSI/HI specifications and standards.

C. Vibration Testing. The packaged pump station shall undergo vibration testing that meets ANSI/HI 9.6.4—Vibration Measurement and Allowable Values—specifications and standards.

D. Flow Testing. The packaged pump station shall undergo Hydraulic Performance Acceptance testing that meets ANSI/HI 14.6 specifications and standards.

E. Wet Test. The entire pump station shall be completely wet tested at the manufacturing facility prior to shipping.

2.15 WARRANTY

A. The Manufacturer shall warrant the original buyer that the packaged pump station shall be free from defects in material and workmanship for a period of thirty-six (36) months from the date of placing the Equipment in operation or forty (40) months from the date of completion of manufacture of the Equipment, whichever shall occur first. The Manufacturer shall provide a 25-year rust-through corrosion warranty on the piping and skid base for Hot Dipped Galvanizing.

PART 3 - EXECUTION

3.1 INSTALLATION, FIELD TESTING, AND START-UP

A. ONSITE PUMP STATION START-UP

a) Technical start-up shall be furnished by the Packaged Pump Station Manufacturer or a qualified service agent. Location and mounting details shall be furnished by the Packaged Pump Station Manufacturer.

b) Electrical connection, by purchaser, shall consist of a single conduit from owners disconnect to the pump station main disconnect. Additional purchaser responsibility shall include confirming correct motor rotation and securing local inspection/approval.

c) Technical start-up procedures by the pump station technician shall include the following:

a. Station start-up and pressurization.
b. Pressure, flow, and programming adjustments.
c. Monitoring of complete operational cycle when possible.
d. Testing of all alarms and fault conditions.
e. Customer training and the presentation of the station operation and maintenance manual.

3.2 SUBMITTALS

A. Submittals shall be well organized, labeled, and presented in a professional manner. Sloppy or poorly presented submittals shall be rejected. The pump station manufacturer shall submit the following items as part of a complete submittal package:

a) Shop Drawings, including 3D models of the proposed pump station. The manufacturer shall also provide digital models that can be viewable from any angle.

b) Electrical Schematics

c) Control Panel Layout Drawing

d) Manufacturers complete packaged pump system UL category QCZJ file number.

e) Technical data sheets for all major system components, including:

a. Pump performance curves and datasheets
b. Control Panel Components: VFD, PLC, Touchscreen Interface, Panel Enclosure, & UL 508A Certification
c. Powder Coating Data
d. Galvanizing Data
e. Valves
f. Instrumentation

f) Operations and Maintenance Manual

B. An electronic operation and maintenance manual shall be furnished at the time of start-up and initial training. The owner shall also receive training specific to the pump station. Operation and maintenance instructions shall contain the following as a minimum:

C. Complete operating instructions, including HMI screenshots with detailed instructions on adjust system parameters and settings.

D. Service and Maintenance instructions.

E. Equipment and driver nameplate data.

F. Electrical schematics.

G. Factory start-up and test data, including pump curves.

3.3 MANUFACTURER QUALIFICATIONS

A. Single Source Responsibility

a) The entire pump station and the control panel shall be designed, assembled, programmed, and tested by a single manufacturer.

B. Certifications

a) The Manufacturer shall be a UL QCZJ Listed Packaged Pump Station Manufacturer, a UL 508A Listed Control Panel Manufacturer, and an ISO 9001:2015 Certified Manufacturer. The Manufacturer shall provide a Certification signed by the owners providing for free phone technical support for the lifetime of the product.

C. Manufacturer Personnel

a) The Manufacturer shall employ service personnel who are trained and certified in every aspect of service that may be required on the pump station. It shall not be acceptable for the control panel to be designed, manufactured, programmed, or tested by any entity other than the Packaged Pump Manufacturer.

D. Approved Manufacturer

a) The pumping system shall be manufactured by Precision Pumping Systems of Boise, Idaho—or pre-approved equal. To be considered an equal manufacturer, proposed manufacturers shall meet the above conditions, shall receive approval no less than 10 days prior to bid date, and shall submit the following:

    a. Shop Drawings of Mechanical System
    b. Theory of Operation
    c. Installation List of 10 similar pumping systems which have been in operation for a minimum of 3 years.
    d. Process & Instrumentation Diagram
    e. Electrical Schematics: One-line diagrams shall not be accepted. A full-color, diagrammatic wiring schematic required.
    f. Control Panel Layout Drawing
    g. Technical data sheets for all major system components, including:
        1) UL QCZJ Certification, UL 508A Certification, and ISO 9001:2015 Certification
        2) Pump performance curves and datasheets
        3) Control Panel Components: VFD, PLC, Touchscreen Interface, Panel Enclosure, and Cooling Method.
        4) Powder coating or Hot Dipped Galvanizing.
        5) Valves
        6) Filtration
        7) Instrumentation

8) Pump station enclosure

3.4 PACKAGED PUMP STATION

A. The Packaged Pump Station supplier shall provide an END SUCTION CENTRIFUGAL pump station complete with pumps, piping, filters, valves, sensors, Variable Frequency Drives, programmable logic controller (PLC), UL 508A listed control panel, and all appurtenances necessary for a complete and functioning pumping system.

B. The pump station—including the pump control panel—shall be designed and manufactured within the confines of a UL 508A, UL QCZJ, & ISO 9001:2015 certified facility. Electrical connection, by purchaser, shall consist of a single conduit from owners disconnect to the pump station main disconnect.

3.5 MECHANICAL SYSTEM

A. GENERAL REQUIREMENTS

a) The mechanical system shall be readily adaptable to meet future requirements, such as increased demand, changes to source water quality, changes to water use monitoring regulations, or the addition of applications requiring filtration.

b) The mechanical system shall be designed and built such that the following mechanical components are readily replaceable onsite without the need to cut or weld any component:

   a. Ability to switch between Vertical Turbine and Submersible Turbine pump types.
   b. Ability to add or remove automatic suction scanning filters, as well as the ability to switch between major filter manufacturers and series, including: Evoqua V Series (VAF), Amiad Filtomat Series, and Amiad SAF Series.
   c. Ability to add or remove a flow meter, as well as the ability to switch between different flow meter types, including electromagnetic and insertion type flow meters.

c) System manifold and appurtenances shall be engineered such that each joint is a union, with all fittings and pipe sections removable without cutting or welding. All piping, fittings, and valves shall have roll-formed grooved connections, with grooved flange adapters provided where connecting to flanged equipment.

d) For ease of maintenance and replacement, each mechanical component, including all fittings and spools, shall include unique part numbers and shall be of a standardized design per ISO 9001:2015.

e) Threaded connections in the piping network are not acceptable.

f) No piping shall be welded to the skid base.

B. PIPING, FITTINGS, AND CONNECTION METHODS

a) Piping

a. System manifold shall be fabricated ASTM A53 Grade B CARBON STEEL, Schedule 40. Manifold shall be sized and designed to minimize pressure loss, with maximum velocity limited to 10 FPS on filtered stations.

b. After fabrication, and before galvanizing, all piping shall be hydrostatically tested to 150% of system operating pressure.

b) Fittings

a. Cast fittings shall be ASTM A536 Ductile Iron with AWWA C606 groove dimensions and hot-dip zinc galvanized per ASTM-123.

b. Welded fittings shall be seamless ASTM A-234 STEEL with AWWA C606 grooved dimensions and hot-dipped zinc galvanized per ASTM-123.

c) Pipe Supports

a. Pipe supports shall be fabricated from ASTM A53 Grade B CARBON STEEL, Schedule 40, and shall be designed to support the full weight of a filled manifold and shall located to ensure that no weight is supported by the pumps. Supports shall be connected to the manifold pipe via non-penetrating cope-weld forming a 100% seal and shall be bolted to the station base via grooved flange adapter.

d) Connection Methods

a. Rigid Type Grooved Coupling System

1) The pump station pipe and equipment connections shall include a rigid type roll-formed grooved coupling system with ASTM A-536 Ductile Iron housing conforming to AWWA C606 groove dimensions and hot-dipped zinc galvanized per ASTM-123. Couplings shall include EPDM gaskets and corrosion inhibiting zinc-plated steel fasteners. The maximum working pressure for rigid grooved couplings shall be 400 WPSI for sizes 1 – 6 inches, and 300 WPSI for sizes 8 – 12 inches.

b. Grooved Flange Adapters

1) Grooved flange adapters shall be ASTM A536 Ductile Iron with AWWA C606 groove dimensions and AWWA Class

D dimensions and shall be hot-dipped zinc galvanized per ASTM-123.

c. Weld Flanges

1) Weld flanges shall be AWWA CLASS D C207 Slip-on type, 175 PSI rated, and provided with Ferolite compressed fiber ring gaskets.

C. Protective Coatings

a) After all fabrication has been completed, the interior and exterior of all piping and fittings shall be grit-blasted to bare steel and HOT-DIPPED ZINC GALVANIZED per ASTM-123 Standards. No welding shall be performed after galvanization.

b) After all fabrication has been completed, the interior and exterior of all piping and fittings shall be grit-blasted to bare steel and coated both internally and externally with thermosetting epoxy powder coating, with a thickness of no less than 10 mils.

c) Proposed alternate systems with pipe coatings that are not warrantied for 25 years shall not be accepted.

D. STATION BASE

a) The system base frame shall be structurally engineered to provide rigid support for the entire pumping system equipment, including but not limited to pumps & motors, manifold, valves, filters, control panel, and station enclosure. The base frame shall enable the entire pump station to withstand all stresses related to transportation, installation, and operation as carried out by qualified personnel.

b) The base frame shall be press-brake formed and fabricated ASTM A36 Steel plate with a minimum thickness of 3/8 inch. The legs of the frame shall be press-brake formed with a minimum riser height of 5 inches and shall include lifting eyes for site offloading and installation, as well as a bent flange with 3/8-inch bolt-holes for on-site anchoring to a concrete pad. The frame shall be structurally reinforced with 3/8-inch-thick ASTM A36 Steel Flat Bar skip-welded to the underside of the frame.

c) The frame deck shall include an integral level sensing equipment access cap.

d) After all fabrication has been completed, the entire base frame shall be grit-blasted to bare steel and HOT-DIP GALVANIZED per ASTM-123 Standards. No welding shall be performed after the base frame is galvanized.

e) Open rail type structural support systems shall not be accepted.

f) Lifting eyes shall be provided on skid for loading and unloading.

g) Proposed alternate systems with base frame coatings that are not warrantied for 25 years shall not be accepted.

E. VALVES

a) Isolation Valves – Grooved Type

a. Provide pump and station isolation valves as shown on the drawing. Valves shall be butterfly type with Grooved connections, ANSI 150 Ductile Iron Body, ANSI Ductile Iron Disc with NBR coating, and 410 SS Valve Stem. Lever operators shall be provided for sizes 6″ and smaller; gear operators shall be provided for valves 8″ or larger; operators shall have a position indicator. Valves shall have a maximum pressure rating of 165 PSI.

b) Check Valves – Grooved, Split-disc

a. Valves shall be of the dual disc type, grooved style with torsion spring induced closure. The body shall be of one-piece construction incorporating a vulcanized synthetic seal. Seal design shall include a raised sealing bead for positive seating at both high and low pressures. The disc shall fully overlap the synthetic seal, preventing pressure indentations. Opening and closing of the valve shall utilize a lift and pivot action to prevent seal wear and ensure long seal life.

c) The valve body shall be constructed of ductile iron. The disc shall be constructed cast bronze ASTM B584 C83600. The pivot pins and stop pins shall be Type 316 stainless steel. The torsion spring shall be Type 316 stainless steel. The seal shall be Buna-N. Check Valves shall be Series #8800G as manufactured by Val-Matic or approved equal.

F. Air Relief Valves

a) Air relief valves shall continuously discharge entrapped air in the system and shall be constructed of a cast iron body with stainless steel float and trim. The discharge shall be piped to the floor drain. Air vent shall have a maximum working pressure of 175PSI. Air relief valves shall be manufactured by Val-Matic or approved equal.

3.6 INSTRUMENTATION

A. Pressure Gauges

a) Pressure gauges shall be located as shown on the technical drawing. Pressure gauges shall have a 304 stainless steel case and bezel construction. Gauges shall be 2.5” diameter, liquid filled. Pressure sensing connection shall be 1/4" NPT lower gauge connection.

B. High Pressure Switch

a) A high-pressure switch shall be located on the station discharge manifold. It shall signal a system fault if the discharge pressure reaches a user-adjustable setting, with the adjustment mechanism located on the switch. The high-pressure switch shall be manufactured by IFM or approved equal.

C. Pressure Transmitters

a) The station shall have pressure transmitters located as shown in the technical drawing. The pressure transmitters shall provide noise free, linear output that is proportional to pressure. Transmitter shall be solid-state, strain gauge type with integral voltage regulation and output accuracy not less than 0.4%. Transmitter shall be constructed of stainless steel and rated for the pump station discharge pressure called out in the technical specifications. The pressure transmitter shall be manufactured by ROSEMOUNT or approved equal.

D. Electromagnetic Flow Meters

a) The pump station shall have a flow meter installed as shown on the technical drawing, installed according to manufacturer's recommendations.

b) The flow meter shall be electromagnetic design comprising of two major components, a primary head, and a signal converter. The primary meter head shall incorporate a straight-thru flow design with no moving parts or pressure loss.

c) The flow meter signal converter shall produce two separate signals, pulse and 4-20ma, in linear proportion to flow rate. Flow data, including flow rates and flow totals, shall be accessible via the door-mounted PLC touchscreen interface.

d) Provide an optical isolator to share the flow signal with an external controller.

e) Flow meter shall read flows from 0.10 - 39 FT/S, with an accuracy of +/- 0.25%. Flow meter shall be sized so that maximum system flow lies between 16 and 24 FT/S through the meter.

f) The meter shall be fully tested during the pump station full run performance testing while at the factory prior to shipment. The magnetic flow meter on the pump station shall be calibrated against a master meter.

g) The flow meter shall be Badger Meter M2000 series or equal.

E. Pressure Tank

a) The pump station shall include a WELL-X-TROL WX-302 86 gallon pre-pressurized diaphragm-type well tank. The tank shall be mounted to the skid. Construction shall be a steel shell, heavy duty butyl diaphragm, polupropylene liner, and Tuf-Kote coating.

3.7 MOTOR CONTROL PANEL

A. General Requirements

a) The Motor Control Panel shall incorporate all circuits and necessary protections required to operate the pump station, including motors, controls, and heating and ventilation circuits. All wiring shall conform to NEC and UL 508A standards for safety.

b) The control panel shall be designed, built, tested, and UL 508A listed by the pump station manufacturer. The control panel shall be UL labeled as an "Enclosed Industrial Control Panel". The pump control panel shall be completely manufactured, tested, and programmed prior to delivery to the job site.

c) Electrical connection, by purchaser, shall consist of a single conduit from owners disconnect to the pump station main disconnect.

d) The control panel shall be installed inside the pump station enclosure. Control panels mounted outside of the pump station enclosure shall not be accepted.

e) The following shall be permanently affixed to the inside of the control panel enclosure:

   a. A full-color, diagrammatic wiring schematic.
   b. Pump and motor nameplate information.
   c. Factory calibrated control setpoints.

B. Panel Construction – NEMA 3R

a) The pumping station electrical controls, including variable frequency drives and operator interface, shall be housed in a NEMA 12 enclosure.
b) The enclosure shall be fabricated from carbon steel, 12 gauge minimum, coated inside and out with ANSI-61 gray powder coating.
c) All internal components of the enclosure shall be mounted on a removable sub-panel, which shall be powder coated white. Mounting screws for components shall not be tapped into the enclosure wall.
d) The electrical panel doors shall be removable and interchangeable, with concealed hinges and integral latches. Door gasket seals shall be oil-resistant and shall be sufficient to protect interior components from weather and dust.
e) All external operating devices shall be dustproof and weatherproof.

f) No pressure gauges, pressure switches, water activated devices, or water lines of any sort shall be installed in the control panel.

C. MCP Temperature Regulation

a) The PLC shall monitor the internal temperature of the control panel using an internal temperature probe. The controller shall automatically fault or send an alarm when the internal temperature reaches user adjustable high/low temperature settings.

b) The cooling system shall interface with the pump station controller for alarms and notifications.

c) The cooling system shall be sized for local maximum ambient conditions, plus component cooling requirements. Cooling should be designed such that the internal panel temperature does not exceed 104F.

d) Control panel temperature regulation shall be via a self-contained, closed loop AC cooling unit. The cooling unit shall utilize compressor-based refrigeration technology with two independent air paths – one which circulates enclosure-side air across the evaporator to displace unwanted heat within the enclosure, and one which circulates ambient air across the condenser to transfer waste heat to the ambient environment.

e) Cooling Unit shall be NEMA 12, 3R, 4 listed and constructed with galvanized sheet-metal coated in RAL 7035 light-gray, semi-textured powder-coat paint.

f) AC Units shall include a mechanical thermostat, digital temperature display, R134A earth-friendly refrigerant, and a cleanable & reusable aluminum mesh coil-protection filter.

g) The cooling unit shall be Hoffman Spectracool series or approved equal.

D. Service Rated Main Disconnect

a) A three-pole, main station disconnect shall be contained within the control enclosure. The main disconnect shall be non-fused and isolate all power to the control enclosure. The main disconnect shall have an operating handle mounted in the enclosure door, mechanically interlocked to prevent entry while disconnect is in the ON position.

E. Control Transformer

a) The control transformer shall provide 120-volt power to the pump station controls. The control transformer shall be protected on primary side with appropriately sized fuses. Secondary side shall be protected by a group of supplementary miniature circuit breakers.

F. Voltage Monitor

a) The control panel shall include an industrial three phase line voltage monitor. It shall protect the system against voltage unbalance, high/low voltage, phase loss, faulty power, incorrect sequencing, and rapid short cycling. It shall

include a fully programmable LED backlit display. It shall be ICM Controls model ICM455 or approved equal.

G. Surge Protection

a) The control panel shall include an industrial grade surge protective device with individual thermally fused and protected MOVs. The surge protector shall provide 50kA per phase protection and shall be UL Listed 1449 for Type 1 SPD applications.

H. Secondary Control Circuit Breakers

a) Single-pole secondary distribution breakers with appropriate ratings shall supply power to each pump starter coil circuit, and control system.

3.8 DOOR-MOUNTED PILOT DEVICES

A. General Requirements

a) All devices shall be IP66 rated, providing complete protection from dust, as well as complete protection from high pressure water jets from any direction.

B. Motor Selector Switches

a) An HOA switch shall be provided for each motor circuit. Switches shall be modular, 3-position maintained, illuminated with green light, and include chrome metal bezel.

C. Speed Potentiometer

a) A speed potentiometer shall be provided for manual speed control of VFD driven motors. Potentiometer shall by a modular knob-type with chrome metal bezel and rated 5 kOhm.

D. Pilot Lights

a) System status indicating lights shall be provided, with a red light to indicate system faults and a green light to indicate when a pump is running. Lights shall be 22mm diameter and equipped with a light diffusing lens.

E. Variable Frequency Drives (VFDs)

a) Provide a dedicated VFD for the jockey pump and a Main VFD to be alternated between the duty pumps. The duty pump VFD shall be automatically alternated between duty pumps based on pump starts, run-time, and faults.

b) Variable Frequency Drive(s) shall be mounted inside the control panel enclosure, with each VFD isolated from main input power by use of a contactor to protect the VFD from power outside of tolerances.

c) The variable frequency drive shall be IGBT based with selectable carrier frequency up to 15 KHZ. The VFD shall include terminals for incoming power, motor output power and control terminals. All VFDs shall include an RS485 port built-in to the VFD for dedicated communication to the PLC.

d) The VFD shall generate a sine-coded, variable voltage/ frequency, three phase output for optimum speed control. The VFD shall incorporate power loss ride-through for a minimum of 2 seconds. VFD protective features shall include current limit, auto restart, short circuit protection, electronic motor overload protection, and ground fault protection. The VFD shall have a push button programming display for easy access to operation parameters. The VFD shall be protected on the primary side by a breaker of the appropriate amperage.

   a. Overload capacity: 120% rated output current for one minute.
   b. Voltage fluctuation: +10%, -15%.
   c. Sine wave, PWM, with full range, and automatic torque boost.
   d. Frequency control range: 0 to 500 Hz.
   e. Frequency accuracy: digital, 0.01 Hz, analog, .1%. Motor overload protection, instantaneous over current of 180% of rated output current.
   f. Over voltage at 820vdc if 460v input.
   g. Under voltage shall be user adjustable.
   h. Momentary power loss: up to 2 second ride through.
   i. Electronic ground fault.
   j. Led capacitor charge indicator.
   k. Input phase loss alarm.
   l. Ambient temperature range of 0 to 40 degrees c.
   m. Humidity of 95% non- condensing allowed.

e) Manufacturer: ABB ACQ580 Series with ISO 9001 certification or pre-approved equal.

F. DOL Motor Starting Equipment

a) The pump station motor controller shall include interlocking contactors to automatically energize/de-energize the lag-designated duty pump motor. Direct online starting equipment shall be an industrial motor starter unit with contactor and thermal-overload protection breaker.

3.9 PUMP SYSTEM CONTROLLER

A. General Requirements

a) Non-Proprietary, Open-Source Programming

a. To better facilitate owner access to system servicing, the control system shall be non-proprietary and open source. Proprietary control systems shall not be accepted.

b) Dual Language HMI Interface

a. To ensure that the control system warnings and parameters can be safely understood by a wide range of operators, the interface shall have a user-selectable English or Spanish Interface.

c) Controller User Guide

a. The pump station manufacturer shall supply an owner's manual in digital form that includes graphic images of all touch screens, complete with explanations of all settings and modes.

d) Programmable Logic Controller (PLC)

a. PLC shall consist of a central processor with built-in dual port Ethernet and USB connection. Processor shall be capable of expanding up to 4 I/O expansion modules and include the following features:

1) High-speed counter with 100 kHz maximum input frequency
2) Pulse output with 100 kHz maximum output frequency
3) Supply Power shall be 24V DC with maximum 35A maximum inrush current.
4) Environmental Ratings
   a) Class 1, Division 2 Hazardous Location
   b) Operating Temperature: -25 to 65 degrees Celsius
   c) 10 – 95% Relative Humidity
5) Program Storage
   a) Serial Flash Memory using embedded SD Card Slot
   b) RAM Backup via lithium battery capable with up to 4 years battery life.
6) Communications Interface
   a) 1-USB Mini-B USB Standard 2.0
   b) 2 Ethernet Ports with RJ45 Connector
   c) Protocols
   d) Modbus TCP
   e) Modbus RTU

f) Ethernet/IP

g) Bacnet

B. Manufacturer/Series

a) IDEC MicroSmart FC6A Plus or approved equal

3.10 OPERATOR INTERFACE

A. General Requirements

a) The touchscreen shall allow operator access to all system settings and monitoring data.

b) The operator interface shall be a Color TFT LCD touchscreen

c) The touchscreen shall be mounted to the motor control panel door.

d) A VFD control keypad is not an acceptable substitution for the digital operator interface.

e) The operator interface shall allow the user to adjust the system parameters & settings to the PLC program locally without requiring any additional equipment such as a laptop computer.

f) System must be capable of programming VFD's via touchscreen (for 3-phase systems only)

B. Hardware Features

a) High Resolution Display with 640 x 480 pixels, with a minimum screen diagonal length of 10.4″.

b) Backlight with 100,000 hours

c) Supply Power shall be 24V DC with maximum 30A maximum inrush current.

d) Environmental Ratings

a. NEMA 4X

b. Class 1, Division 2 Hazardous Location

c. Operating Temperature: -20 to 60 degrees Celsius

d. 10 to 90% Relative Humidity, non-condensing

e) Communications Interface:

a. 1 Mini-B USB Standard 2.0

b. 1 Ethernet Port with RJ-45 Connector

c. RS232C or RS485

f) Program Memory Storage

a. 2GB SD Memory Card

C. Manufacturer/Series: IDEC High Performance Series or Pre-Approved Equal.

D. Monitoring Functions

E. System Dashboard

a) Pressure, flow, and level status.
b) Pump status, including lead pump designation, VFD frequency, torque, kw and current draw.
c) Alarm conditions, with the ability to manually reset alarms.
d) Current values of all system sensors, including pressure and flow.
e) User selectable language icon.

F. Fault Log

a) The controller shall have a system fault log that displays the precise times of fault occurrences and recoveries, as well as message indicating the fault type. The fault log shall include a fault diagnosis utility that provides possible causes of and solutions to all system faults and warnings.

G. Trend Log

a) Trend graphing screen capable of detailing pressure, flow, and current data. Graphing function shall give the option to graph and plot a point at user adjustable intervals. All data shall be capable of being downloaded to a USB drive and accessible over Ethernet through FTP server. Trend log shall be .csv format.

H. Advance I/O diagnostics

a) HMI display must include utility screen that displays the current status of all digital and analog inputs/outputs, including device tag name (i.e. pump #1 auto). This function must be accomplished without opening the control panel.

I. Control Functions

a) The LCD color touchscreen must be capable of alternating between English and Spanish during operation by an end-user accessible button located within an operator screen. The system diagnostic utility must be capable of being displayed in both English and Spanish.

b) Control system must be capable of adding industry standard components without program modifications. Including but not limited to:

a. Additional main pumps up to four
b. Fill devices (valve/pump)
c. High level float
d. Master valve

e. Additional filters

f. Rain sensor

J. Pressure Settings

a) Pressure transmitter calibration, discharge pressure setpoint, and high/low pressure alarm/fault conditions.

K. Flow Settings

a) Low and high flow alarm conditions, flow meter sensor calibration settings, and total gallons pumped with user reset button and time/date stamp of last reset. In addition, a non-resettable flow totalizer.

L. Level Settings

a) Low- and high-level alarm conditions, level transmitter calibration settings, and level-based pressure setpoint manipulation.

M. Pump Settings

a) Pump detail screens showing total run hours of each pump since last reset and any modes, options, or functions specific to that pump. Must include troubleshooting utility as a visual display of pump permissive.

N. Automatic Filter Controls

a) Shall include two user selectable automatic flush modes - 1) Pressure Differential and 2) Timed Interval. System shall also include a manual flush capability.

b) Remote Start/Stop Signal Relay

c) The PLC shall be able to start and stop the system based on a remote signal relay.

O. Pre-programmed Start-Up Routines

a) The PLC shall be programmed with various start-up routines that limit and/or delay the starting and acceleration of the pump—ensuring that excessive velocity and pressure do not damage the distribution system.

b) The program shall include individual routines for initial start-up, mainline fill, re-start after a power outage, and re-start after a system fault.

c) The operator shall be able to adjust the timing of the routines via the operator interface.

P. Password Protection

a) Unique user selectable password.

Q. Loading and Saving System Default Settings

a) The system shall allow the operator to Load Factory Default PLC settings, Save New Operator settings, and Load previously saved Operator PLC settings.

b) The PLC shall allow the operator to change the system date and time.

R. Scheduler

a) 7 day per week scheduler.
b) Multiple run times per day and speed/flow rate.
c) User assignable device scheduler consisting of 3 unique daily schedules for each applicable device.
d) Devices included but not limited to:
    a. Main pumps
    b. Jockey/PM pump
    c. Fill pump
    d. Master valve
    e. Fill valve

S. System Protections

a. Controls shall shut down the pump station in the event of the alarm conditions described in this section, as well as otherwise indicated. The system controls shall attempt to restart the system after alarm shutdown or loss of power. After a user-adjustable number of attempts to re-pressurize the system, the controls shall go into hard shut down and remain so until manually reset.

b. Low Flow Shutdown. The PLC shall automatically shut down the system if there is no, or too little flow, based on signals received from a flow switch. The low flow shutdown shall have a user adjustable time delay.

c. Low Level Shutdown. The controller shall automatically shut-down the system based on low level signals from a level transmitter.

d. High Pressure Shutdown. In addition to the pressure data received from the pressure transmitter, the PLC shall automatically shut-down the system based on signals from a high-pressure switch.

e. Electrical Fault Shutdowns. Incoming power high, low, and imbalance limits. Shut-down and restart time delays shall be user-adjustable.

f. Analog Transmitter Failure. Input levels of all connected transmitters and meters shall be monitored for failures.

g. Motor starter failure. Circuit breaker and/or motor overload contacts shall be monitored to indicate a motor failure.

T. Communications

a) Web-Based Remote Monitoring and Control

a. The pump station control panel shall include a web-based remote control and monitoring system.

b. Remote Monitoring must be capable of alternating between English and Spanish during operation by an end-user.

c. Remote monitoring and control system shall be non-proprietary and not require a 3rd Party Application.

d. The pump station shall be capable of being remotely monitored from any device with a web browser, such as a PC, tablet, or smart phone.

e. Monitoring of pump station shall be seamless to the user via a web browser that shall be started by simply clicking on a hyperlink. Software shall not be required to be installed or configured on the user's computer.

f. The web page shall include full graphical representation of the pump station and its features and shall be capable of remotely changing all operating parameters of the pump station.

g. The pump station shall automatically send email or text alerts regarding warnings and faults and specify the station and specific fault/alarm.

h. The pump station manufacturer shall supply all required communication hardware except computer and computer accessories, including all necessary direct burial cable and antennas.

i. A cellular modem shall be mounted and wired inside control panel enclosure.

j. The connection shall be capable of communicating to the pump station over cellular modem, high speed Ethernet, or fiber optic cable.

U. Flow Signal Sharing

a) The control panel shall include an optical isolator to share the flow meter signal with a separate controller.

V. SCADA INTEGRATION

a) Control system must be provided with separate isolated network with user adjustable network settings from HMI. Future/optional equipment or updates must not be required for integration.

b) Must support communication protocols simultaneously.

   a. Ethernet/IP
   b. Modbus TCP

c) Must have instructions for communication map on HMI including device name, scaling units, format, and associated address (i.e., discharge pressure, xxx.x PSI, UINT – Modbus address xxxxx).

3.11 ONSITE PUMP STATION START-UP

A. Technical start-up shall be furnished by the Packaged Pump Station Manufacturer or a qualified service agent. Location and mounting details shall be furnished by the Packaged Pump Station Manufacturer.

B. Electrical connection, by purchaser, shall consist of a single conduit from owners disconnect to the pump station main disconnect. Additional purchaser responsibility shall include confirming correct motor rotation and securing local inspection/approval.

C. Technical start-up procedures by the pump station technician shall include the following:

a) Station start-up and pressurization.

b) Pressure, flow, and programming adjustments.

c) Monitoring of complete operational cycle when possible.

d) Testing of all alarms and fault conditions.

e) Customer training and the presentation of the station operation and maintenance manual

END OF SECTION

SECTION 11805

DIESEL-ENGINE-DRIVEN GENERATOR SET

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the furnishing and delivery of materials, equipment and appurtenance for the diesel engine driven generator for the pump station to be installed outdoors as shown on the Contract Drawings. The contractor shall provide a complete engine-powered standby electrical generating system of the type and capacity indicated with TIER 4 certified rating.

B. Related Requirements:

1. Section 01300: Submittals
2. Section 11010: General Mechanical Equipment Provisions
3. Section 16050: General Electrical Work
4. Section 16250: Transfer Switches
5. Section 17010: Instrumentation and Control Process Systems

1.2 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

6. Include airflow requirements for cooling and combustion air in cubic feet per minute (cubic meters per minute) at 0.8 power factor, Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight for provided components; fuel tank, enclosure, silencer, base tank, each piece of equipment not integral to the engine generator.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams indicating terminal markings for engine generators and functional relationship between all electrical components.
7. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report. Perform tests at rated load and power factor. Provide the following test results:

a) Maximum Power Level
b) Maximum Motor Starting (sKVA)
c) Structural Soundness
d) Torsional Analysis
e) Transient Response
f) Alternator Temperature Rise

g) Engine Cooling Requirements (unit mounted radiator)
h) Harmonic Analysis (per IEEE-115 and ANSI-100)
i) Voltage Regulation
j) Endurance Testing

2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Report of factory test on units to be shipped for this Project, indicating evidence of compliance with specified requirements.
4. Report of sound generation.
5. Report of exhaust emissions indicating compliance with applicable regulations.
6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

C. Field quality-control reports. Field start up report and unit in-service documentation, including load bank test results if applicable.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. Include manufacturer's recommended maintenance and periodic testing plan in accordance with NFPA 110, Chapter 8.

B. Furnish extra materials required by local Authority Having Jurisdiction (AHJ) and defined in project documents that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.6 QUALITY ASSURANCE

A. The generator set covered by these specifications shall be designed, tested, rated, assembled and installed in accordance with all applicable standards below:

a. CSA C22.2, No. 14-M91 Industrial Control Equipment.
b. CSA C22.2, No. 100 Motors and Generators
c. CSA 282-15
d. EN 61000-6
e. EN 55011
f. FCC Part 15 Subpart B
g. ISO 8528
h. IEC 61000
i. UL 508
j. UL 2200
k. UL 142
l. UL 6200
m. Designed to allow for installed compliance to NFPA 37, NFPA 70, NFPA 99 and NFPA 110

B. Manufacturer Qualifications:

1. Current certificate holder for ISO 9001 compliance.
2. The power system shall be produced by a manufacturer who has produced this type of equipment for a period of at least 25 years and who maintains a service organization of factory-authorized generator technicians available twenty-four hours a day throughout the year.

C. Installer Qualifications: An authorized representative who is trained and certified by the manufacturer on stationary power systems.

D. Permits from Local Air Quality District: Contractor shall submit engine emissions data and required fees and obtain a "Permit to Construct" from local Air Pollution Control District in the Owner's name prior to delivery of engine-generator set to jobsite.

E. The supplier shall maintain a local part and 24-hour service facility within the State of California. The supplier shall have factory trained and authorized service representatives to furnish necessary installation, test, and start-up supervision as well as operation and maintenance training necessary for final approval and acceptance.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

B. Warranty: 5 Year Comprehensive from date of Substantial Completion.

C. A Comprehensive Warranty is defined as the manufacturer covering replacement parts, labor, and limited technician travel costs for covered warranty repairs during the listed warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Generac Power Systems, Inc.; 80 kW, 4.5 L with a K0100124Y21-80kW alternator. The Three Phase generator shall be rated for 80 kW at 277/480 volts 4-wire and 60 Hz, at 0.8 power factor lagging while operating at a maximum ambient temperature of 122 Fahrenheit and maximum altitude of 3500 feet above sea level without reduction in electrical output capacity. Products by one of the following will also be considered:

a. Caterpillar, Inc.
b. Cummins Power Generation.

c. Or Approved Equal.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic – non-OSHPD: Provide materials, bracing, and mounting to ensure generator will withstand, and continue to operate, through a seismic event. Present seismic calculations and certificate for the specific model generator in accordance with the relevant IBC and ASCE standard. This will include drawings of the generator and mounting details. Seismic Performance: Engine generator housing, sub-base fuel tank, engine-generator assembly, and batteries, battery racks, silencers, sound attenuating equipment, accessories, and components to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7 when required on the project.

B. NFPA Compliance:

a. Comply with NFPA 37.
b. Comply with NFPA 70.
c. Comply with NFPA 99.
d. Comply with NFPA 110 requirements for Level 1 EPSS.

C. UL Compliance: Engine generator assembly and factory enclosure (if provided) shall be UL 2200 listed.

D. Engine Exhaust Emissions: Comply with applicable US EPA, State and Local Government requirements. Spark-ignited Stationary Emergency: Engines shall be certified by the manufacturer to comply with 40 CFR Part 60 Subpart JJJJ, Table 1, Emission Standards for Stationary Emergency SI Engines and Table 2, Requirements for Performance Tests.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Power Rating: Standby.

D. Service Load: The generator set shall be a Generac model 80 kW, 4.5 L with a K0080124Y21-80kW alternator. It shall provide 80 kW and 100 kVA while operating at the maximum ambient operating temperature and elevation specified in the project documents.

E. Power Factor: 0.8 lagging.

F. Frequency: 60 Hz.

G. Voltage: 277/480 Volts ac.

H. Phase: Three Phase, Four Wire.

I. Induction Method: Turbocharged.

J. Fuel-Oil Tank: 189 Gallon Double Wall, Full Load Running Capacity: 30 hours

K. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

L. Nameplates: For each major system component to identify manufacturer's name, model and serial number of component.

M. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 11.67 percent variation for 50 percent step-load increase or decrease at unity power factor. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 3.5 Hertz variation for 50 percent step-load increase or decrease at unity power factor. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined in accordance with NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start time to comply with NFPA system requirements.

2.4 ENGINE PERFORMANCE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15. Engine shall be capable of operating on hydrotreated vegetable oil blends (up to HVO 100) conforming to the EN 15940 specification without modification.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System to be engine mounted.

1. Oil filter shall be engine-mounted replaceable cartridge type with integral bypass valve, in accordance with manufacturer recommendations.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Jacket water heater shall be sized per NFPA110 and UL listed to ensure that genset will start within the specified time period and ambient conditions.

E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gauge glass and petcock.
3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
4. Maximum Ambient Operating Temperature on Radiator: 104 degrees F (40 degrees C).
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a) Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    b) Meets SAE 100R1A Type S, EN853 1SN, ISO 1436-1 Type 1SN
    c) a Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer:

Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

G. Air-Intake Filter: Heavy duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

H. Starting System: 12 or 24-V electric, with negative ground.

1. Cranking Cycle: As required by NFPA 110 for system level specified.

2. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle as required by NFPA 110 for system level specified.
3. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 minimum continuous rating.
4. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and NFPA 110 Section 5.6.4.6 for Level 1 systems.:

2.5 FUEL SYSTEM – DIESEL

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 2 microns.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

F. Tank level indicator.
F. Leak detection in interstitial space.
F. Vandal-resistant fill cap.
F. Containment Provisions: Comply with requirements of authorities having jurisdiction. Secondary containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a primary tank rupture.
F. Normal and emergency vents on the main tank and secondary containment space, sized according to UL 142.

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine

generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.

D. Control panel must comply with UL 6200. The controller shall meet ASTM B117 (salt spray test).

E. Connection to Building Management: Provide connections for data transmission of indications to remote data terminals via Modbus.

F. Environmentally Hardened Design: Open circuit boards, edge cards, and PC ribbon cable connections are unacceptable.

G. PCB Construction: Circuit boards with surface-mounted components to provide vibration durability. Circuit boards utilizing large capacitors or heat sinks must utilize encapsulation methods to securely support these components.

H. Configuration:

Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel powered from the engine generator battery.

I. Control and Monitoring Panel:

1. Digital engine generator controller with integrated touch screen, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
2. Instruments: Located on the control and monitoring panel and viewable during operation.

    a) Engine lubricating-oil pressure gauge.
    b) Engine-coolant temperature gauge.
    c) DC voltmeter (alternator battery charging).
    d) Running-time meter.
    e) AC voltmeter, for each phase.
    f) AC ammeter, for each phase.
    g) AC frequency meter.
    h) Generator-voltage adjusting feature.

3. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:

    a) Cranking control equipment.
    b) Run-Off-Auto switch.
    c) Control switch not in automatic position alarm.
    d) Overcrank alarm.
    e) Overcrank shutdown device.
    f) Low-water temperature alarm.
    g) High engine temperature pre-alarm.
    h) High engine temperature.
    i) High engine temperature shutdown device.
    j) Overspeed alarm.
    k) Overspeed shutdown device.
    l) Low fuel pressure.
    m) Coolant low-level alarm.
    n) Coolant low-level shutdown device.
    o) Coolant high-temperature prealarm.
    p) Coolant high-temperature alarm.
    q) Coolant low-temperature alarm.
    r) Coolant high-temperature shutdown device.
    s) EPS load indicator.
    t) Battery high-voltage alarm.
    u) Low cranking voltage alarm.
    v) Battery-charger malfunction alarm.
    w) Battery low-voltage alarm.
    x) Lamp test.
    y) Contacts for local and remote common alarm.
    z) Remote manual stop shutdown device.
    aa) Total engine run hours, non-resettable.
    bb) Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

J. External Alarm & Status Relays: Provide a separate terminal block, factory wired to Form C dry contacts, for each alarm and status condition required by Building Management or other external systems as shown on electrical drawings.

K. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

L. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Low water-temperature alarm.
3. High engine temperature pre-alarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low-cranking voltage alarm.
19. Generator overcurrent-protective-device not-closed alarm.

M. Remote Emergency-Stop Switch: Provide remote emergency stop switch in quantity and style as shown on electrical drawings. Electrical contractor to coordinate exact location with engineer and local AHJ.

N. Data Logging:

1. Event Logging – the controller keeps a record of up to 8,000 events with date and time locally for warning and shutdown faults. This event log can be downloaded onto a USB storage device or onto a PC through the service program.
2. Event Snapshot – the control system shall capture 15 seconds of critical data around the time a fault or warning. This data shall be viewable on the controller and downloadable.
3. Data Logging – the controller shall allow customized parameters to be logged based on a start trigger from the controller interface.

    a) The parameters are selectable from all monitored parameters.
    b) The sample period shall be configurable from 1 second to 1 day.
    c) The collected data shall be stored on a USB storage device plugged into the control panel.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Unit mounted circuit breakers. Rating, ampacity, accessories, as shown on drawings or as listed below:
2. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

    a) Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
    b) Trip Settings: Selected to coordinate with generator thermal damage curve.
    c) Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
    d) Mounting: Adjacent to, or integrated with, control and monitoring panel.

C. Generator Controller Integrated Alternator Protective Functions:

1. Short-time I^2t function : Generator controller-based function shall continuously monitor current level in each phase of alternator output, integrate alternator heating effect over time, and predict when thermal damage of alternator will occur. As overcurrent heating effect on the alternator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits.
2. Long-time function: Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
3. Short-circuit fault clearing: Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Range: Provide range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity. Stator shall be skewed construction to minimize harmonic voltage distortion.

G. Enclosure: Drip proof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator:

1. Voltage Regulator: Solid-state type, separate from exciter. The digital voltage regulator shall be microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain steady-state generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS. The regulator shall provide an adjustable Volts/Hz slope regulation characteristic in order to optimize voltage and frequency response for site conditions.
2. Alternator Excitation: Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
3. The generator must accept rated load in one-step.

a. System Transient Voltage Performance: Alternator shall be capable of supplying 227 sKVA with a voltage dip not more than 35% at 0.3 starting power factor. Sustained voltage dip data or manufacturer-published SKVA numbers based on unity PF alternator-only dynamometer testing will not be accepted.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. The engine generator, while operating at full rated load, shall not exceed the following sound criteria:

a. Level 2 Acoustic Enclosure, Steel
b. Industrial Grey Baked-On Powder Coat Finish
c. Average Sound Level, 72 dBA at 23 ft

B. Generator packaged within manufacturer's weather protective, sound attenuated enclosure. Enclosure and generator set shall be UL 2200 Listed as a system.

C. Enclosure Construction: Minimum 14 gauge construction. Roof construction shall be raised-seam, gasket-free interlocking panels. Rivets shall not be used on external painted surfaces. Design shall be rodent resistant.

D. Doors shall be equipped with lift-off pin and sleeve type hinges to allow access to the engine, alternator, and control panel. Hinges shall be adjustable for door alignment. Hinges and all exposed fasteners shall be stainless steel. Each door shall be equipped with minimum 2-point latching mechanism and identical keys. Perimeter of all door openings shall include polyethylene gasket.

E. Upward discharging exhaust hood for engine cooling airflow and exhaust.

F. Engine exhaust silencer mounted within enclosure discharge hood.

G. Enclosure Finish: Electrostatic applied powered paint, baked and finished to manufacturer's specifications. Finish system shall be subjected to the following tests:

1. ASTM D1186 - 87; 2.5+ mil Paint Thickness
2. ASTM D3363 - 92a; Material Hardness
3. ASTM D522 - B; Resistance to Cracking
4. ASTM D3359 - B; Adhesion
5. ASTM B117 D 1654; Resistant to Salt Water Corrosion
6. ASTM D1735 D 1654; Resistant to Humidity
7. ASTM 2794 93 (2004); Impact Resistance
8. SAE J1690 - UV Protection"

H. Enclosure Color: Manufacturer's standard color, or custom color matched based on architect's design with color sample provided to generator manufacturer.

I. Wind Rating: Enclosure shall be constructed to attain basic wind speed rating of 110 MPH; WIF 1.15, Exposure Category "C", Building Classification "Enclosed", Topographic Factor Kzt = 1. Wind Design Pressures: windward, 20.6 lb/ft^2; leeward, -12.9 lb/ft^2; roof, -18.0 lb/ft^2."

J. Snow Load Rating: Minimum 70 pounds per square foot.

K. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

L. Sound Insulation: Enclosure and air discharge hood completely lined with reflective silver mylar faced sound attenuating closed cell foam that meets UL 94 HF1 standards for flammability (FMVSS 302 test method). Roof sound insulation panels shall include additional mechanical retention.

M. Sound Performance: The engine generator, while operating at full rated load, shall not exceed 76.00 dBA average measured at 23 ft (7 meters) from the engine generator in a free field environment.

N. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.

O. Convenience Outlet: Factory-wired convenience 120v duplex-outlet within enclosure, GFCI.

P. Interior Lighting: Factory-wired LED fixtures controlled by switches at each access door opening.

2.10 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment for units with a ratings 80kw or below.

Material: Standard neoprene separated by steel shims.

B. Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint for units with a rating larger than 80kw.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 0.5.

C. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

Tests: Comply with IEEE 115 and with NFPA 110, Level 1 Energy Converters.

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
7. Single-step load pickup.
8. Safety shutdowns.
9. Report factory test results within 10 days of completion of test.

2.12 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service in accordance with requirements indicated:

1. Notify Project Manager in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases or steel dunnage as indicated on drawings.
2. Coordinate size and location of mounting bases for packaged engine generators.
3. Install unit with vibration isolation devices described in section 2.11.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections: The supplier of the electric generating plant and associated items covered herein shall provide factory certified technicians to inspect the completed installation and to perform an initial startup inspection to include:

1. Ensuring the engine starts (both hot and cold) within the specified time.
2. Verification of engine parameters within specification.
3. Verify no load frequency and voltage, adjusting if required.
4. Test all automatic shutdowns of the engine-generator.
5. Perform a load test of the electric plant, ensuring full load frequency and voltage are within specification by using building load.

B. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.

C. Battery and Charger Tests:

1. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions.
2. Verify that measurements are within manufacturer's specifications."

D. System Integrity Tests: Verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

E. Coordinate tests with tests for transfer switches and run them concurrently.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest and reinspect as specified above.

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations.

3.5 START-UP ASSISTANCE AND TRAINING

A. The manufacturer's representative shall furnish on-Site start-up assistance and shall inspect the installation prior to start-up to verify that equipment is installed in accordance with the manufacturer's requirements.

B. Upon completion of startup and after acceptance by the OWNER, the CONTRACTOR shall completely fill the fuel tank.

C. In addition, the manufacturer's representative shall provide on-Site training for operation and maintenance of all equipment included in this Section.

D. The following times shall be included, as a minimum, for the above tasks. A Day is defined as 8 hours on-Site, exclusive of meals and travel. Each task shall be considered a separate trip to the site. Dates and times for the trips shall be coordinated with the OWNER.

E. Inspection of the installation: One day

F. Startup assistance and training: One day

G. Operation and Maintenance Training: One day

3.6 MAINTENANCE SERVICE

A. Repair Service Capabilities:

1. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including: engines, alternators, control systems, paralleling electronics, and power transfer equipment.

2. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within 50 miles of the site.
3. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

B. Preventative Maintenance Service Agreement: The supplier shall include a three-year maintenance service agreement. The maintenance shall be performed by factory authorized service technicians capable of servicing both the engine generator set(s) and the transfer switch(es). This agreement shall include semi-annual preventative maintenance visits to verify operation and/or complete the following:

1. All periodic engine maintenance as recommended by the service manual.
2. All electrical controls maintenance and calibrations as recommended by the manufacturer.
3. All auxiliary equipment as a part of the emergency systems.
4. The supplier shall guarantee emergency service.
5. All expendable maintenance items are to be included in this agreement.
6. A copy of this agreement and a schedule shall be provided in the submittal documents, detailing scope of work and preventative maintenance service visit interval.

END OF SECTION

SECTION 13120

PRECAST CONCRETE BUILDING

PART 1 – GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install a prefabricated concrete building on a prepared site. Building may be fully assembled, or field assembled.

B. Building to be provided by manufacturer with all necessary openings as specified by contractor in conformance with manufacturer's structural requirements and written specifications set forth herein.

1.02 QUALITY ASSURANCE

A. ACI-318-11, "Building Code Requirements for Reinforced Concrete". Concrete Reinforcing Institute, "Manual of Standard Practice".

B. ANSI/ASCE-7-10 "Building Code Requirement for Minimum Design Loads in Buildings and Other Structures".

C. CBC 2013

D. 2013 CBC Title 24 (Part 2) - Accessibility

E. 2013 Cal Green Code - Sustainability

F. Concrete Reinforcing Institute, "Manual of Standard Practice".

G. Fabricator must be a certified producer/member of The Precast/Prestressed Concrete Institute (PCI).

H. At time of bid, Building fabricator must have a minimum of 5 years' experience manufacturing and setting transportable precast concrete buildings.

I. Licensed by the California Department of Housing and Community Development

J. All site assembly and building connections work shall be performed by a qualified representative of the manufacturing company. Manufacturing company shall at all times prior to bid and during construction have and maintain a Class B - California General Contractors License

1.03 DESIGN REQUIREMENTS

All walls are minimum 4" thick roof and floor sections are 6" thick**.**

A. Design Loads:

1. Seismic load performance category ‘D’, Exposure Group I

2. Standard Live Roof Load – 60 PSF

3. Standard Floor Load – 250 PSF

4. Standard Wind Loading – 130 MPH

B. Sloped Roof: Roof panel shall slope ½” from front to back in 10-foot direction. The roof shall extend a minimum of 2” beyond the wall panel on each side and have a turndown design which extends ½” below the top edge of the wall panels to prevent water migration into the building along top of wall panels. Roof shall also have an integral architectural ribbed edge.

C. Roof, floor, and wall panels must each be produced as single component monolithic panels. No roof, floor, or vertical wall joints will be allowed, except at corners. Wall panels shall be set on top of floor panel.

D. Floor panel must have ½” step-down around the entire perimeter to prevent water migration into the building along the bottom of wall panels.

1.04 SUBMITTALS

A. Engineering calculations and erection drawings that are designed and sealed by a professional engineer registered in the State of California

B. Shop drawings to specify types and materials of all structural wall embeds.

C. California Department of Housing and Community Development – manufacturer’s certificate.

D. California General Contractors License

E. PCI - Certified Plant Certificate

F. 5000 PSI Concrete mix design with test reports.

G. Product data for doors and door locks

H. Concrete stain color chart for engineering color selection.

I. ALL Optional items chosen by engineer clearly noted on building submittal sheet including welding certificates if applicable.

1.05 WARRANTIES

A. Provide manufacturer's written weather-tightness warranty for a maximum of twenty (20) years against leaks in roof panels arising out of or caused by ordinary wear and tear under normal weather and atmospheric conditions.

B. Provide manufacturer's standard written warranty for twenty (20) years against perforation of metal roof panels due to corrosion under normal weather and atmospheric conditions. Warranty shall be signed by metal roofing system manufacturer.

C. Manufacturer's Certification: Submit written Certification by the signed manufacturer during submittal review process that the metal roof system manufacturer will provide warranties and Inspection and Report Service specified herein. Warranty terms shall be submitted during submittal review process. Also included in this submittal will be certification of the manufacturer's compliance with AISC-MB category.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. EASI – SET Brand as manufactured by StructureCast, Bakersfield CA, or pre-approved equal.

2.02 MATERIALS

A. Concrete: Steel-reinforced, 5000 PSI minimum 28-day compressive strength, air-entrained (ASTM C260).

Xypex shall be added to all concrete batches as a waterproof additive.

B. Reinforcing Steel: ASTM A615, grade 60 unless otherwise specified.

C. Precast Floor and Roof members shall be Post Tensioned. Roof and floor to be each post-tensioned by a single, continuous tendon. Post-tensioning cable shall be 41K polystrand CP50, .50", 270 KSI, 7-wire strand, enclosed within a greased plastic sheath (ASTM A416). Said tendon shall form a substantially rectangular configuration having gently curving corners wherein the positioning of the cable member results in a pattern of one or more loops and a bisecting of the loop(s). The cable member starts from one corner of the concrete building panel, forms a gentle perimeter loop(s) returning to a point where the cable member entered the concrete building panel. The tendon then turns 90 degrees and follows the cable member(s) to a point midway along the "Y" axis of the concrete building panel and then turns 90 degrees along the "X" axis of the concrete building panel. This bisects the concrete building panel and crosses the opposite parallel portion of the cable member and exits from an adjacent side of the concrete building panel.

D. Caulking: Joint between building and floor slab shall be caulked on the exterior and interior surface of the joints. Caulking shall be SIKAFLEX-1A elastic sealant or equal. Exterior caulk joint to be 3/8" x 3/8" square so that sides of joint are parallel for correct

caulk adhesion. Back of joint to be taped with bond breaking tape to ensure adhesion of caulk to parallel sides of joint and not the back.

E. Vents: Two screened aluminum vents to be cast in rear wall. Vents shall be SUNVENT #164FL or equal.

F. Panel Connections: All panels shall be securely fastened together with 3/8" thick ***Stainless Steel*** embedded weld plates of structural quality. All fasteners to be ½" diameter bolts complying with ASTM A307 for low-carbon steel bolts. Cast-in anchors used for panel connections to be Dayton-Superior #F-63, or equal. All inserts for corner connections must be secured directly to form before casting panels. No floating-in of connection inserts shall be Stainless Steel plates shall be welded using Stainless Steel welding rod. All welding shall be performed by a certified welder with certificates supplied at time of bid.

2.03 ACCESSORIES

A. Doors and Frames:

1. Shall comply with Steel Door Institute "Recommended Specifications for Standard Steel Doors and Frames" (SDI-100) and as herein specified. All door and frame galvanizing shall be in accordance with ASTM A924 and A653 for hot dipped steel and shall be of the 0.6 oz class of galvanizing.

2. Buildings shall be equipped with 3068 or 6068 doors: 16 gauge (.045"), 1.75" thick insulated steel. Active doors shall be non-handed, prepared for a cylindrical lever lock, flush top cap and three hinges.

3. Active doors shall be reinforced with minimum, 16 gauge (.072") closer reinforcements to support surface mounted hardware.

4. Doors and frames shall meet SDI standard Level 3 model 1: Heavy Duty 1 ¾" Flush Hollow Metal Doors.

5. Frames shall comply with ANSI 250.8-2003 (SDI-100) and be constructed of 16 gauge hot dipped galvanized (.053") steel in a depth to match the wall thickness. Frames shall be knocked down, mechanically fastened, or welded, cast in place or post anchored as required. Strike jambs shall be prepared to receive three rubber mutes to cushion door closing.

6. Doors and frames shall be reinforced to receive surface applied hardware. Minimum 7 gauge hinge reinforcements shall be used to prevent door sag.

7. Doors and frames shall be factory treated with an anticorrosive phosphate solution to inhibit rusting and to etch metal to accept top coating of field applied finishes. Doors and frames shall be given one coat of rust inhibitive primer and one finish coat of enamel paint.

8. Doors, frames and hardware shall comply with the requirements under 2010 ADA Standards for Accessible Design.

B. Door Hardware: Limited Lifetime Warranty on Mechanical assemblies as noted

1. Hinges: Hinge standards shall comply with ANSI 156.17 Grade 1, (3 per door minimum) Hinges shall meet NFPA 80 label requirements for 3 hour fire doors. Hinges shall be 32D (Type 630) Satin Stainless Steel with non-removable pins. Manufacturer shall provide a Limited Lifetime Warranty on this product. Approved manufacturers: Design Hardware, Hager, or equal.

2. Cylindrical Lock: BEST Series 9K or Schlage ND series with lever, ANSI 156.2, Series 4000, Grade 1. UL listed ADA approved. Dormitory function. Deadlocking latch bolt x levers except when locked by push button in inside lever. Key in outside lever locks or unlocks outside lever and releases button. Closing door releases push button. Inside lever always free. Zinc dichromate chassis with cast solid zinc levers to resist corrosion. Furnish locks with 6 pin solid brass standard Schlage "C" keyway. All locks to be keyed alike. Manufacturer shall provide a Limited Lifetime Warranty on this product.

3. Dead Bolt to be Schlage B Series, Grade 1. A156.36 – 2010 High Traffic, Heavy Duty or similar.

4. Drip Cap: Aluminum drip cap with minimum projection of 2 ½" shall be furnished. Drip cap to extend 2" beyond each end of opening to allow for appropriate protection against the elements. Approved manufacturers: National Guard Products, Design Hardware or equal

5. Door Stop: ANSI 156.16 Approved wall mounted door stop with keeper constructed of a corrosion resistant cast brass material. Finish 26D (Type: 626) Brushed Chrome Finish. Approved manufacturers: Don Jo, ABH or equal.

6. Door Sweep: Nylon brush door sweep, with drip edge. ANSI/BHMA certified. Sweeps shall be approved for UL 10C Positive Pressure and suitable for use with fire doors rated up to three hours. Approved manufacturers: National Guard Products or equal.

7. Surface Closers: LCN Series 40 or 41 and set for full compliance with CBC / ADA closer delay times. Mount all closers on inside of exterior doors.

C. HEAT PUMP UNIT

1. Heat pump unit shall be Amana Model No. PBH073G35CB equipped with an accessory wall sleeve model No. PBWS01A, or equal.

D. ELECTRICAL EQUIPMENT PAD

1. Building shall come with a built-in electrical equipment pad with dimensions as shown on drawings and shall be of 3" thickness.

E. LOUVERS

1. Provide as shown on drawings.

2.04 FINISHES

A. Interior of Building: Smooth steel form finish on all interior panel surfaces.

B. Exterior of Building: Architectural precast concrete brick finish: Finish must be imprinted in top face of panel while in form using an open grid impression tool similar to EASI-BRICK™. Finished brick size shall be 2 3/8" x 7 5/8" with vertical steel float or light broom finish. Joints between each brick must be 3/8" wide x 3/8" deep. Back of joint shall be concave to simulate a hand-tooled joint. Each brick face shall be coated with the following acrylic concrete stain: H&C Concrete Stain by Sherwin Williams. Stain color shall be Brick Red unless specified otherwise. Stain shall be applied per manufacturer's recommendation. Joints shall be kept substantially free of stain to maintain a gray concrete color.

C. Exterior of Building (Option): Additional finishes are available and will vary by local producer.

D. Floor to receive a two part, non-slip, epoxy coating, interior and exterior walls to receive Sherwin Williams H&C Concrete Stain. Color per engineer.

2.05 INSULATION: REQUIRED

A. Provide rigid foam insulation sandwiched within the precast wall and roof sections.

2.06 LIGHTING

A. Electrical items are to be as shown on the electrical drawings and as specified in Division 16

PART 3: EXECUTION

3.01 SITE PREPARATION REQUIREMENTS

A. Substrate below pavement or slab must have a vertical soil capacity of 1,500 pounds per square foot. Place stone or sand to 1” above highest point of area where building will be placed and at least 1’-0” wide all around the building footprint. Retain stone or sand with a perimeter form to prevent the material from washing out.

B. Provide positive drainage for the fill, concrete pad, or slab as required.

3.02 ACCESS

A. Contractor must provide a level unobstructed area large enough for a crane and a tractor-trailer to park adjacent to the pad. Crane must be able to place outriggers within 5’-0” of edge of pad and truck and crane must be able to get side by side under their own power. No overhead lines may be within 75’ radius of center of pad. Firm roadbed with turns that allow 65’ lowbed tractor-trailer must be provided directly to site. No building shall be placed closer than 2’-0” to an existing structure.

END OF SECTION

SECTION 15010

GENERAL PROCESS AND ONSITE UTILITY PIPING PROVISIONS

PART 1: GENERAL

1.01 SCOPE

This section contains general provisions applicable to all process and onsite utility piping. Specific requirements for each type of pipe to be used are provided in other sections of Division 15. Where specific requirements for a particular type of pipe are different than those in this section, the specific requirements shall govern.

1.02 RELATED WORK IN OTHER SECTIONS

A. Section 01300: Submittals

C. Section 01667: Testing of Pipelines

D. Section 02223: Trenching, Backfilling, and Compacting

E. Section 10400: Identifying Devices

F. Section 15080: Piping Accessories and Appurtenances

G. Section 15094: Hangers and Supports

H. Section 15097: Seismic Restraint for Piping

I. Section 15100: Valves

1.03 DRAWINGS

Drawings are diagrammatic and show the general design, arrangement and extent of the systems. Do not scale drawings for roughing in measurements, nor use as shop drawings. Make field measurements and prepare shop drawings as required. Coordinate work with shop drawings of other specification divisions.

1.04 SUBMITTALS: IN ACCORDANCE WITH SECTION 01300.

A. Submittals shall be provided for the following items plus any additional items required in the specifications for the particular types of pipe:

1. Piping and jointing materials

2. Fittings

3. Specialties

4. Fabrication drawings of all major runs of pipe and all pipe which cannot be fabricated in the field.

5. The arrangement of piping and appurtenances proposed to serve equipment of other than the first named manufacturer.

B. Contractor shall investigate the space requirements of the proposed piping before submitting shop drawings.

PART 2: MATERIALS

2.01 GENERAL

Pipe sizes are minimum nominal inside diameter unless otherwise noted. All sizes of pipe shall be as called out on the drawings and specified herein. All pipe and fittings delivered to the job site shall be clearly marked to identify the material, class, thickness, and manufacturer. All material shall be new and free of blemishes.

2.02 PIPING MATERIALS

A. The Piping Materials Schedule lists the pipe materials that can be selected at the Contractor's option for each service, except where the drawings call for a specific pipe material. For any service not listed in the schedule, the pipe material shall be as allowed for a similar or connecting service of the same size.

B. The Piping Materials Legend lists the pipe types and specification sections for the piping referred to by symbols in the Piping Materials Schedule.

PIPING MATERIALS SCHEDULE

Symbol	Service	Material		Pipe ID Code (a)	Test Pressure PSI (b)
		Underground or Encased	Exposed		
WN	Non-Potable Water	J	F (< 3-inches), A (≥ 3-inches)	3	125
WP	Potable Water	J	F (< 3-inches), A (≥ 3-inches)	3	125
C	Culvert	A, B	A, B	2	10
SD	Storm Drain	V	V	2	50
SS	Sewer (Gravity) (e)	V, A, G	A	3	10
RS	Raw Sewage (Pumped) (d, e)	A, I	A	2	100
V	Vent	J	J	2	10

(a) See Section 10400.
(b) See Section 01667.
(c) Piping schedule lists all piping materials used unless otherwise shown on the drawings.
(d) All Pumped Piping system shall be restrained.
(e) Special lining- Ductile Iron pipe and fittings shall be lined with 'Perma Shield 431' or approved equal.

PIPING MATERIALS LEGEND

Symbol	Description	Specification Section
A	Ductile Iron	15062
B	Corrugated Metal Pipe	---
C	Copper	15031
F	Schedule 40 Steel, Galvanized	15051
G	HDPE	15075
J	Schedule 80 PVC	15071
K	C900 PVC	15071
Q	304L Stainless Steel Pipe Schedule 10s	15052
V	PVC Sewer Pipe, SDR 26, or Schedule 40 ABS	15071

2.03 POLYETHYLENE ENCASEMENT

All buried metallic piping, valves, specials, and fittings shall be polyethylene encased, double wrapped – 8 mils thickness, sized to pipe diameter, ANSI/AWWA-C105/A21.5.

PART 3: EXECUTION

3.01 HAULING, UNLOADING AND DISTRIBUTING PIPE

A. During loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe, coating, and lining. No pipe shall be dropped from cars or trucks, or allowed to roll down slides without proper retaining ropes. Each pipe shall rest on suitable pads, strips, skids or blocks securely wedged or tied in place. Padding shall be used on car or truck stakes, skids, etc., to prevent damage to the pipe during transportation and handling. Any pipe damaged shall be replaced or repaired as approved by the Engineer at no additional cost to the Owner.

B. Each section of pipe shall be delivered in the field as near as practicable to the place where it is to be installed. Pipes shall be distributed along the side of trench opposite to the spoil bank within easy reach of the installing crew.

Where it is necessary to move the pipe longitudinally along the trench, it shall be done in such a manner as not to injure the pipe. Pipe shall not be rolled or dragged on the ground. Where pipe is placed on stockpiles, it shall be neatly piled and blocked with strips between tiers.

3.02 INSTALLATION OF PIPELINES AND FITTINGS

A. Trenching and Backfill:

1. Except as otherwise noted on the plans or specified herein, all excavation and backfilling for piping shall be as specified in Section 02223, "Trenching, Backfilling, and Compacting".

2. Pipelines located in or under fill areas shall not be placed until the fill has been constructed and compacted to an elevation at least one (1) foot above the elevation of the top of the pipe.

3. All backfill other than where concrete encasement is required, for pipelines installed under structures, slabs, footings, and paving shall be made with sand and fine gravel, thoroughly compacted in place to not less than 95% of maximum density.

B. Grades and Elevations:

1. All piping and appurtenances shall be installed in the position and to accurate lines, elevations, and grades as shown on the plans or specified herein. Where possible, piping shall be sloped to permit complete drainage. All pipelines shall be rigidly supported and braced by approved hangers, brackets, or other devices. When temporary supports are used, they shall be sufficiently rigid to prevent any shifting or distortion of the piping or related work.

2. Furnish all fittings necessary for the satisfactory alignment and arrangement of piping and all necessary unions and cleanouts.

3. An invert grade rod shall be used in laying all lines below ground.

C. Flexible Couplings:

1. Flexible couplings shall be installed where shown on the drawings and at such other points as may be required for ease of installation or removal of the pipe, subject to approval of the Engineer. Where necessary to prevent separation of pipe due to internal pressures, flexible couplings shall be of the type with set screws in the retainer gland or shall be provided with tie rods as approved by the Engineer. Where permanent flexibility is required, however, such as at connections to pumps or other equipment, and elsewhere as called for on the drawings, tie rods shall be the only acceptable restraining devices and shall be installed through separate mounting plates or lugs and not through flange bolt holes, in order to retain flexibility.

2. Where rubber or similar flexible couplings are called for on the Drawings, tie rods shall be provided if recommended by the manufacturer to prevent excessive elongation.

D. Flexible Joints: For pipelines extending from a concrete structure into earth, at least two flexible joints shall be provided in the earth within 3 feet of the structure face, one of which may be cast in structure with end flush with structure face. Piping beyond structure shall adequately supported by proper compaction under pipe or by supporting on firm undisturbed soil if necessary.

E. Union and Flanges:

1. In erecting the pipe, a sufficient number of screwed unions or flanged joints shall be used to allow any sections or runs of pipe to be disconnected without taking down adjacent runs. Screwed unions shall be used on pipelines two and one-half (2-1/2) inches in diameter and smaller. Flanged joints shall be employed in pipelines three (3) inches in diameter and larger.

2. All exposed piping shall be provided with rigid joints as necessary to prevent shifting or separation due to internal pressures, seismic forces, or the weight of the pipe and it's contents. Rigid joints shall include flanges, grooved couplings, screwed joints, welded joints, soldered joints, etc., unless otherwise noted on the drawings.

F. Concrete Thrust Blocks: Unless noted otherwise, concrete thrust blocks shall not be allowed except at specific locations shown on the drawings. Thrust blocks shall be poured between the pipe or fitting and undisturbed earth.

1. In the absence of concrete thrust blocks, all pressure piping (for ductile iron, HDPE, and PVC) joints shall be restrained.

G. Concrete Wall and Slab Penetrations:

1. Hydraulic Conditions - Piping passing through concrete walls normally below liquid level shall be installed with one of the following:

a. Cut-off collar cast on ductile iron fittings or pipe, ¼-inch thick, 3-inches wide.

b. Cut-off collar welded to steel fittings or pipe, ¼-inch thick, 3-inches wide.

d. Cored, canned, or sleeved hole of suitable size to be sealed with a modular mechanical interlocking EPDM synthetic rubber links shaped to continuously fill the annular space between pipe and opening, equal to "Link-Seal" by Thunderline Corp., Wayne, MI, along with grout as shown on the detail Drawings.

2. Non-Hydraulic Conditions -

a. Piping passing through concrete walls, slabs, or footings from earth to earth shall have provision for reasonable relative movement by wrapping pipe with one-inch fiberglass entire thickness of concrete.

b. Horizontal or vertical piping passing through concrete walls, sidewalks, slabs, or footings from earth to air shall be wrapped with 3/8-inch thick, 60 durometer, rubber sheeting, secured with banding.

c. Cored, canned, or sleeved hole 3 inches to 7 inches larger diameter than the pipe; pack with non-shrink grout.

H. Connections to Equipment:

1. The pipework of all pumps and equipment shall be adequately supported throughout and the weight thereof shall be carried independently of the pump casings or the equipment. All pipework shall be mounted parallel with vertical and horizontal axes of reference. All sections of pipe shall be rigidly bolted or joined together after being cut accurately to length in such a manner as to relieve any and all parts of equipment of undue strain resulting from closure of flanged or other joints or connections.

2. Equipment shall be so positioned and aligned that no strain shall be induced within the equipment during or subsequent to the installation of pipework.

I. Pipe Joints:

1. Pipe shall be cleaned of dirt and scale prior to installation and all joints swabbed clean before jointing. Ends of all pipe shall be closed or plugged at the end of each day's work or otherwise as necessary to prevent the entrance of foreign materials.

2. The Contractor shall perform all work of cutting pipe and special castings necessary to the assembly, erection and completion of the work. All pipe shall be cut and reamed to fit accurately with smooth edges.

J. Coatings for Buried Valves and Piping Accessories: All buried valves, flange assemblies, flexible connections, flange coupling adapters and similar fittings shall be coated with petrolatum wax tape. All buried nuts, bolts, washers, tie rods, and other threaded fasteners shall be Xylan/flouropolymer coated “Blue Bolts” or Type 316 stainless steel.

K. Coatings for submerged valves and piping accessories: All submerged items shall be coated as per Section 9900. All submerged nuts, bolts, washers, tie-rods, and other threaded fasteners shall be Type 316 stainless steel.

3.03 IDENTIFICATION: SEE SECTION 10400.

3.04 TESTING: SEE SECTION 01667.

3.05 CLEANING AND FLUSHING

A. All pipelines shall be cleaned of all soil, dirt, rocks, and other debris and objectionable material.
B. Pipelines 24-inches in diameter and smaller shall be cleaned first by pulling a tightly fitting cleaning ball or swab through the pipe. Pipelines larger than 24-inches in diameter may be cleaned manually or with a cleaning ball or swab.
C. After initial cleaning, flush the interior of all piping. Upon completion of flushing, completely drain systems at all low points; remove, clean, and replace all strainer baskets and refill systems.

END OF SECTION

SECTION 15051

STEEL PIPE

PART 1: GENERAL

1.01 DESCRIPTION

This section consists of furnishing and installing steel pipe and fittings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 02221: Utility Trenching and Backfilling

C. Section 02223: Trenching, Backfilling and Compaction

D. Section 15010: General Process and Onsite Utility Piping Provisions

E. Section 15080: Piping Accessories and Appurtenances

F. Section 15094: Hangers and Supports

G. Section 15100: Valves

H. Section 15097: Seismic Restraints for Piping

1.03 QUALITY ASSURANCE

A. References: This section contains references to some or all of the following documents, latest revision. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

REFERENCES	TITLE
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings

ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory-Made Wrought Steel Butt Welding Fittings
ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded

REFERENCES	TITLE
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series including Hex Cap Screws and Lag Screws
ANSI B18.2.2	Square and Hex Nuts (1983)
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
API STD 1104	Welding Pipelines and Related Facilities
ASME	Boiler and Pressure Vessel Code
ASTM A36/A36M	Structural Steel
ASTM A47	Ferritic Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High Temperature Service
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A283/A283M	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A536	Ductile Iron Castings
ASTM	Steel, Sheet and Strip, Carbon, Hot Rolled, Structural

A570/A570	Quality
ASTM A572/A572M	High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality
AWWA C200	Steel Water Pipe 6-Inches and Larger
AWWA C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. and Larger - Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services - Sizes 4 in. through 144 in.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA M11	Steel Pipe - A Guide for Design and Installation
SSPC	Steel Structures Painting Council Specifications

B. Testing: Factory testing shall conform to the requirements of ASTM A53, ASTM A106, OR AWWA C200 as applicable.

1.04 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Show materials of construction, with ASTM reference and grade. Submit manufacturer's certificates of compliance with referenced pipe standards, e.g.,

ASTM A 312, A 403, A774, A 778. Show wall thickness of steel cylinder and fittings.

C. Submit piping layout drawings showing the location and dimensions of the pipe and fittings larger than 3 inches nominal diameter. Include layout lengths of valves, meters, blowers, and other equipment determining piping dimensions. Label or number each fitting or piece of pipe.

D. Submit manufacturer's data for flange and coupling gaskets.

E. Submit certifications that welders are qualified in accordance with ANSI B31.1, Paragraph 127.5 for shop and project site welding of pipe work.

PART 2: MATERIALS

2.01 SCHEDULE 40 AND 80

A. Pipe:

1. Galvanized if indicated in Section 15010, otherwise black with lining and/or coating as specified in Section 15010 and this section.

2. 2½-inches and smaller: ASTM A53, threaded couplings. Grooved couplings are an acceptable alternative for 2 ½-inch pipe.

3. 3-inches and Larger: ASTM A53, butt-welded, grooved couplings, or flanges.

B. Fittings:

1. Galvanized or lined and/or coated same as pipe.

2. 2½-inches and smaller: malleable iron, ASTM A197, ANSI B16.3, Class 150. Alternatively, 2-½-inch fittings may be as specified below for 3-inches and larger.

3. 3-inches and larger: Steel, ASTM A234, ANSI B16.9, Sch. 40, Sch. 80, or ductile iron in accordance with Section 15062; ends to match pipe.

C. Screwed Joint Seal: Teflon tape.

D. Flanges: per 2.04, this Section.

2.02 AWWA C200

A. Pipe: In accordance with AWWA C200. Steel shall conform to the requirements of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM

A283, Grade D. Pipe shall be straight or spiral seam. Unless indicated otherwise, minimum design pressure shall be 125 psi.

B. Couplings: Butt weld, grooved end, or flanged for exposed service, Carnegie bell and spigot with rubber gasket, grooved, or welded except where indicated or required to be flanged or plain end for flex couplings for buried service.

Pipe and fitting mortar lining, coating and steel wall thickness shall be as noted below in Table 1:

Table 1

Pipe Diameter, in.	Mortar Lining Thickness, in.	Steel Wall Thickness, in.	Mortar Coating Thickness, in.
Buried Service			
18	0.3125	0.1875	1.00
20	0.3125	0.1875	1.125
24	0.3750	0.1875	1.250
30	0.3750	0.2500	1.500
36	0.3750	0.2500	1.750
42	0.5000	0.3125	1.750
48	0.5000	0.3125	2.000
54	0.5000	0.3125	2.250
60	0.5000	0.3125	2.500

C. Fittings and Specials:

1. ASTM A234, or fabricated steel, AWWA C200, AWWA C208; lining, coating, and ends to match pipe. Pressure rating and wall thickness shall be equal to pipe or greater.

2. The type of reinforcement required for outlet, tee or wye branches on fabricated fittings shall be determined in accordance AWWA M11, Steel Pipe – A Guide for Design and Installation.

2.03 FLANGE ASSEMBLIES

A. Flanges: Unless otherwise specified or required for the installation, steel flanges

shall be ANSI B16.5, Class 150, plain face or AWWA C207, Class D. Where 300 lb flanges are called for, they shall be forged steel, raised face in accordance with ANSI B16.5. Plain faced flanges shall not be bolted to raised face flanges.

B. Gaskets:

1. Full face or ring type gaskets shall be cloth inserted neoprene.

2. Gaskets for plain faced flanges shall be the full face type. Thickness shall be 1/16-inch for pipe 10-inches and less in diameter and 1/8-inch for pipe 12-inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16-inch thick for pipe 3½-inches and less in diameter and 1/8-inch thick for pipe 4-inches and larger.

C. Bolts: Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head carbon steel machine bolts with ANSI B18.2.2 standard hot pressed hexagon nuts. Threads shall be ANSI B1.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5. Flange assembly bolts and nuts for exposed service shall be zinc phosphate coated. Flange assembly bolts and nuts for submerged or buried service shall be 303, 304, or 316 stainless steel as approved by the Engineer regardless of any other protective coating.

2.04 THREAD

Pipe thread dimensions and size limits shall conform to ANSI B2.1.

2.05 PIPE LINING

A. Liquid Epoxy: Unless otherwise specified or noted on the drawings, pipe and fittings shall be lined with liquid epoxy as specified in AWWA C210 to a minimum thickness of 16 mils in not less than two coats. Pipe and fittings for fuel oil return and supply shall be unlined.

B. Coal Tar Enamel: Where specified, pipe and fittings shall be lined with coal tar enamel as specified in AWWA C203.

C. Cement Mortar: Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205.

D. Fusion Epoxy: Where specified, steel pipe and fittings shall be fusion epoxy lined and coated in accordance with this section

2.06 PIPE COATING

A. Liquid Epoxy: Unless otherwise specified, pipe and fittings for buried installation

shall be coated with liquid epoxy, shop applied in accordance with AWWA C210 to a minimum thickness of 16 mils in not less than two coats.

B. Polyethylene Tape Wrap:

1. Where specified, underground and encased steel pipe shall be given a corrosion protective wrapping as set forth herein. Pipe shall be spirally wrapped with Polyvinyl Chloride or Polyethylene pressure sensitive tape applied with a suitable primer. The wrap shall have a nominal thickness of 20 mils, consisting of either one layer of 20 mil tape or 2 separate layers of 10 mil tape.

2. Before the primer and wrap is applied, the piping shall be thoroughly cleaned so that all surfaces shall be dry and free of dirt, dust, rust, mill scale, oil, grease or other foreign matter. Any solvents used shall be totally volatile so as to leave no trace of oil. Weld spatter, burrs or sharp points and edges shall be removed by chiseling, ball peening, or filing. After thorough cleaning, the piping shall be coated with a primer applied in accordance with the tape manufacturer's recommendations. The primer shall be Minnesota Mining "Scotchwrap Pipe Primer", or equal.

3. After cleaning and priming, the piping shall be spirally wrapped with the pressure sensitive tape of the proper width for the pipe size on which it is being used, as recommended by the manufacturer. The tapes shall be tightly applied with a ½-inch minimum uniform lap, free from wrinkles and voids. Approved wrapping machines may be used. Tape shall be Minnesota Mining "Scotchwrap" No. 51, or equal.

4. The field joints and fittings shall be covered as specified for wrapping pipe, except that a nominal 10 mil thick tape having a maximum width of 2-inches shall be used for fittings. Two thicknesses of the tape shall be applied to the fittings to provide a covering 20 mils thick over all surfaces. The tape shall be applied with adequate tension so that the tape will conform and adhere tightly to all surfaces of the fitting, without air pockets. "Scotchfil", or equal, shall be used to fill voids, flange faces around bolts, and other irregular surfaces, to provide a smooth even surface for the application of the tape wrap. Pipeline flanges and unions shall be completely wrapped. Where valves are in the pipelines, the pipe wrap shall cover the pipe flange and extend over the outer edge of the valve flange or the threaded portion of the valve body. The unwrapped surfaces of the valves shall be given two heavy coats of a coal tar enamel conforming to AWWA C204. Adequate drying time shall be allowed before backfilling or wax coating.

5. Tape wrapped pipe shall be handled and stored in a manner to protect the wrap from damage. It shall not be dropped, walked on, rolled, or handled in any manner that might damage the wrap. Any skids or supports for

temporary storing or holding of wrapped pipe shall be wide and padded to prevent cutting of this wrap. Where it is necessary to handle wrapped pipe with slings or cradles, they shall be of wide rubber or canvas.

6. Tape-wrapped pipe and fittings shall be coated with a one-inch thick cement mortar shield coating in accordance with AWWA C205. Use spiral wire reinforcement for pipe and wire mesh or fabric for fittings and specials.

C. Cement Mortar: Where specified, pipe and fittings shall be coated with cement mortar in accordance with AWWA C205. Use spiral wire reinforcement for pipe and wire mesh or fabric for fittings and specials.

2.07 FUSION EPOXY COATING AND LINING

A. Where specified or shown on the drawings, steel pipe and fittings shall be fusion epoxy coated and lined. The fusion epoxy coating shall be 3M Scotchkote 206N (fluidized bed grade), or equal. Surface preparation shall be in accordance with SSPC-SP 10 Near White Blast Cleaning. The application method shall be by the fluidized bed method and shall attain 16 mils minimum dry film thickness.

B. Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with 3M Scotchkote 312.

2.08 GROOVED JOINTS

A. In accordance with AWWA C606, except as modified herein.

B. Roll groove pipe if wall thickness is less than minimum recommended by manufacturer for cut grooving.

C. For non-submerged applications, bolts and nuts shall be ASTM A183, zinc electroplated to ASTM B633. Provide 316 stainless steel bolts and nuts for submerged applications.

D. Buried joints shall be flexible grooved unless otherwise shown or required for the installation.

E. Exposed joints shall be rigid grooved unless otherwise shown or required for the installation.

F. Unless otherwise noted or required, rigid grooved joints may be substituted where flanged joints are shown on the drawings.

PART 3: EXECUTION

3.01 INSTALLATION

A. Pipe Cutting, Threading and Jointing: Pipe cutting, threading and jointing shall conform to the requirements of ANSI B31.1.

B. Pipe Welding:

1. Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of AWWA C206 for all piping, except Sch. 80. Welds shall be made in accordance with the requirements of ANSI B31.3 for Sch. 80.

2. The Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Engineer prior to that welder working on the job.

C. Restrained Joints: Where restrained joints are required on the Drawings, the restraint may be provided by welded butt joints, welded bell and spigot joints, or grooved joints.

D. Grooved joints shall be installed in accordance with manufacturer's latest published recommendations.

E. Lining and Coating: Pipe lining and coating at field joints shall be applied as specified in Section 15051 - 2.06 and 2.07. Where cement mortar lining and/or coating is required, field joints shall be lined and/or coated to match pipe in accordance with AWWA C205.

3.02 SUPPORT

Pipes shall be adequately supported to prevent sags, kinks, or other deficiencies in appearance of strength. Additional supports shall be installed to provide adequate support, whether or not indicated on the drawings. No pipe shall be left unsupported wherever a change in direction of line of flow takes place. Supports shall meet the requirements stated above, but in no case shall the distance between supports exceed those specified in Section 15094.

END OF SECTION

SECTION 15062

DUCTILE IRON PIPE

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of furnishing and installing ductile iron pipe and fittings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 02221: Utility Trenching and Backfilling

C. Section 02223: Trenching, Backfilling and Compaction

D. Section 15010: General Process and Onsite Utility Piping Provisions

E. Section 15080: Piping Accessories & Appurtenances

F. Section 15094: Hangers and Supports

G. Section 15097: Seismic Restraints for Piping

H. Section 15100: Valves

1.03 QUALITY ASSURANCE

References, American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), Federal Specifications (FS), and the manufacturer's printed recommendations.

1.04 SUBMITTALS

A. In accordance with Section 01300.

B. Materials list and catalog data sheets naming each product to be used identified by manufacturer and type number.

1.05 PRODUCT HANDLING

Handle pipe and fittings in a manner to insure delivery in a sound undamaged condition.

PART 2: MATERIALS

2.01 DUCTILE IRON PIPE

A. Pipe shall conform to ANSI A21.50 (AWWA C115), ANSI A21.51 (AWWA C151), and A21.4 (AWWA C104) as appropriate.

B. Flanged pipe shall be per ANSI A21.15 (AWWA C115) pressure class:

3 – 12-inches	Class 350
> 12-inches	Class 250

C. Pipe wall thickness for grooved couplings shall be Class 54.

D. Pipe wall thickness for push-on joint and mechanical joint pipe shall be Pressure Class 350 psi for pipe 12-inches and smaller, and Pressure Class 250 psi for larger pipe.

E. Pipe shall have PROTECTO 401 lining for raw sewage service and bituminous coated mortor lining for all other service.

F. Buried pipe shall have bituminous coating per ANSI A21.4. Exposed (painted) pipe shall have prime coat compatable with finish coating specified in Section 9900. All exposed pipe with bituminous coating must be sand blasted to remove the bituminous material as required for specified coating system.

G. Standard pipe laying lengths shall be eighteen (18) or twenty (20) feet.

2.02 FITTINGS AND SPECIALS (EXCEPT GROOVED)

A. Cast iron and ductile iron specials and fittings shall conform to ANSI A21.10 (AWWA C110) or ANSI 21.53 (AWWA C153) with joints as shown on the Drawings or as required elsewhere in these Specifications or for the installation. Buried fittings shall have an asphaltic outside coating in accordance with ANSI/AWWA C153/A21.53, except as otherwise noted herein.

B. Interior lining of specials and fittings shall match the adjoining specified pipe lining, except as otherwise noted herein. All standard fittings for raw sewage or sludge service shall be PROTECTO 401 lined. Coatings shall be bituminous, if buried; or as specified in Section 9900.

2.03 FLANGES

A. ANSI B16.1, CLASS 125 unless otherwise indicated, or required for the

installation.

B. Flanges for spool pieces shall be factory installed threaded flanges. Flanges for fittings shall be cast integrally with the fitting.

2.04 RESTRAINED MECHANICAL JOINTS

Where specified, called for on the Drawings, or otherwise required for thrust restraint, mechanical joints shall be made using retainer glands with set screws or clamping lugs. Retainer glands shall be as manufactured by EBAA Iron; Tyler Pipe, or equal. Anti-corrosion coatings are required and shall be Mega-Bond, Tuf-Bond, or equal.

2.05 RESTRAINED PUSH-ON JOINTS

Where specified, called for on the drawings, or otherwise required for thrust restraint, push-on joints shall be Flex-Ring as manufacturer by American Ductile Iron Pipe, TR Flex as manufactured by US Pipe, or equal. Restrained joint shall provide for joint deflection after assembly.

2.06 RUBBER GASKET FOR MECHANICAL OR PUSH-ON JOINT

ANSI A21.11 (AWWA C111), vulcanized natural or vulcanized synthetic rubber.

2.07 FLANGED GASKETS

Full face, 1/16-inch thick cloth inserted neoprene or metallic packing.

2.08 BOLTS & NUTS FOR FLANGES, FITTINGS, and RESTRAINTS

ANSI B18.2.1 and B18.2.2, low alloy, high strength, zinc coated when exposed, Xylan "Blue bolt" or 316 stainless steel when buried, and 316 stainless steel submerged or below top of wall in water bearing structures.

2.09 GROOVED FITTINGS

Cast iron, ASTM A-48, Class 30-A, cement lined. Victaulic, Gustin-Bacon, or equal.

2.10 POLYETHYLENE ENCASEMENT

Buried piping, specials, and fittings shall be polyethylene encased, double wrapped - 8 mils thickness, sized to pipe diameter, ANSI/AWWA-C105/A21.5. Polyethylene shall be black, low density film.

2.11 PROTECTO 401

A. Where specified Protecto 401 shall be applied as indicated by the published specifications of the coating manufacturer.

PART 3: EXECUTION

3.01 INSTALLATION

A. General

1. Pipe shall be laid in accordance with the pipe manufacturer's published instructions, Standard Drawings, and ANSI/AWWA C600, as complimented and modified herein.

a. Cleanliness: The interior of the pipes shall be clean of foreign materials before the sections of pipe are installed and shall be protected to prevent entry of foreign materials after installation.

b. Allowable Deflection: The maximum allowable angular deflection at the joints shall be 80% of the manufacturer’s recommendation for push-on and mechanical joints.

B. Bell and Spigot Ductile Iron Pipe. Where bell and spigot joints are used for joining ductile iron pipe, the joints shall be made using rubber rings, US "Tyton", Clow "Super Bell-Tite" joint, or equal. Gasket seat, gasket, and spigot shall be thoroughly cleaned before assembly of joint. The entire procedure shall be in strict accordance with manufacturer's recommendations.

C. Mechanical Joint Ductile Iron Pipe. Mechanical joints in ductile iron pipe shall be made as follows: Gland shall be placed on spigot end of pipe with lip extension toward the joint. The rubber gasket shall then be slipped on the pipe with its thick edge toward the gland. The gasket and joint surfaces shall then be thoroughly wetted using a soapy solution made with vegetable soap or similar soap as recommended by the manufacturer. The spigot end of the pipe shall then be inserted to full depth of the mechanical joint socket and the gasket pressed firmly into place in the bell in order to obtain an even "set" all around the joint. The gland shall then be moved into place, the bolts inserted and the nuts taken up tightly with fingers. The nuts shall then be tightened gradually by wrench -- a half turn at a time, moving wrench from one nut to another repeating until all nuts are uniformly tight. Final tightness shall be with a torque wrench as follows: three-quarter inch bolts - 60 to 90 pounds torque.

D. Flanged Pipe. Flanged joints shall be made up square, with even pressure on the gaskets, and shall be watertight.

E. Grooved Coupling: Grooved couplings shall be prepared or painted as necessary to obtain a leak-free seal.

F. Polyethylene Encasement for External Corrosion Protection for Buried Piping:

1. General: Provide polyethylene encasement for all buried Ductile Iron Pipe.

2. Installation on Pipe:

a. Pick up the pipe with a sling or pipe tongs. Slip a polyethylene tube which is approximately two feet longer than the pipe over the plain end and leave it bunched up accordion style.

b. Lower the pipe into the trench and make up the joint with the preceding pipe. Shallow bell holes are required to allow overlap of the tube at the joints.

c. Remove the sling or tong from the center of the pipe, raise the bell a few inches and slip the polyethylene tube along the pipe barrel, leaving approximately one foot of the tube bunched up at each end of the pipe for wrapping the joints.

d. Overlap each joint by first pulling one bunched-up tube over the bell, folding it around the adjacent plain end, and securing it in place with two or three wraps of the polyethylene adhesive tape. Complete the overlap by repeating the same procedure with the bunched-up tube on the adjacent pipe.

e. Take up the slack tube along the pipe barrel by folding it over the top of the pipe holding the fold in place with polyethylene adhesive tape.

f. Repair any rips, punctures or other damage to the polyethylene with tape or by cutting open a short length of tube, wrapping it around the pipe and securing with tape.

3. Installation on Fittings, Valves and Piping Specialties:

a. Fit bends, reducers and offsets with polyethylene tube in the same manner described above for pipe.

b. Wrap valves, tees, crosses and specialty items with a flat sheet obtained by splitting open a length of polyethylene tube. Pass the sheet under the valve or fitting and bring it up around the body. Join

the seams by bringing the edges together, folding over twice and securing in place with tape.

c. Handle slack tube and overlapping at joints in the same manner described above for pipe.

d. Prepare openings for service taps, air reliefs, etc., by making an X-shaped cut in the polyethylene and temporarily folding back the edges. After installation is completed, replace the polyethylene and repair the cut with polyethylene adhesive tape.

4. Backfilling

a. Care shall be taken not to damage the polyethylene.

b. Initial backfill material shall be free of rocks and debris which could puncture the polyethylene. If suitable backfill material is not available, felt roofing or similar material can be laid over the top of the pipe to protect the polyethylene.

c. In general, backfilling shall be done in accordance with AWWA Standard C-600.

END OF SECTION

SECTION 15071

PLASTIC PIPE

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of furnishing and installing polyvinyl chloride pipe and fittings.

1.02 PIPE DESIGNATIONS

The following plastic pipe and tubing designations are defined:

Designation	Definition
PVC	Polyvinyl chloride
CPVC	Chlorinated Polyvinyl Chloride
ABS	Acrylonitrile Butadiene Styrene

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 02223: Trenching, Backfilling, and Compacting

C. Section 15010: General Process and Onsite Utility Piping Provisions

D. Section 15080: Piping Accessories and Appurtenances

E. Section 15094: Hangers and Supports

F. Section 15097: Seismic Restraints for Piping

G. Section 15100: Valves

1.04 QUALITY ASSURANCE REFERENCES

This section contains references to some or all of the following documents, most recent edition. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM D3350	Specification for Polyethylene Plastics Pipe and Fittings Materials.
ASTM D1784	Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR series)
ASTM D2464	Threaded Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket-Type Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings
ASTM D3034	Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
ASTM D3050	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F402	Practice for Safe Handling of Solvent Cements and Primers Used

1.05 SUBMITTALS

A. In accordance with Section 01300.

B. Submit materials list and catalogue data sheets naming each product to be used identified by manufacturer and type number.

PART 2: MATERIALS

2.01 PVC PRESSURE PIPE

A. General: PVC materials for pipe and fittings shall conform to ASTM D1784, Cell Classification 12454-B. In addition, additives shall be less than 10% by weight. Pipe and fitting materials shall be specially formulated with sufficient UV protection additives to provide for long-term outdoor exposure with no deleterious effects. Flanges shall be one-piece solid design or two-part van stone type which utilize the tapered, serrated face and full face gasket technique for joining and are compatible with ANSI N16.5 Class 150 metal flanges. Unions shall be the O-ring seal type having interchangeable components with true union valves for maximum system versatility.

B. Schedule 80: Pipe shall be Schedule 80 in accordance with ASTM D1785. Schedule 80 PVC socket type fittings shall conform to ASTM D2467. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464.

Solvent cement shall be as recommended by the manufacturer for each service. Cement for hydroxide and hypochlorite solutions shall be IPS 724 or equal.

C. C900 (Class as indicated in Section 15010): Pipe shall meet the requirements of AWWA C900, "Polyvinyl Chloride (PVC) Pressure Pipe". All Class 165 pipe shall meet the requirements of DR 25, Class 235 pipe shall meet the requirements of DR 18 and Class 305 the requirements of DR 14. All pipe shall be suitable for use as pressure conduit. Provisions must be made for expansion and contraction at each joint with an elastomeric ring. The bell shall consist of an integral wall section with a locked-in, solid cross section elastomeric ring which meets the requirements of ASTM F477. The bell section shall be designed to be at least as hydrostatically strong as the pipe wall and meet the requirements of AWWA C900.

D. C905 (Class as indicated in Section 15010): Pipe shall meet the requirements of AWWA C905, "Polyvinyl Chloride (PVC) Water Transmission Pipe" Class 165. In addition, additives shall be less than 10% by weight. Pipe shall meet the requirements of DR 25. All pipe shall be suitable for use as pressure conduit and shall be cast iron pipe o.d. Provisions must be made for expansion and contraction at each joint with an elastomeric ring. The bell shall consist of an integral wall section with a locked-in, solid cross section elastomeric ring which meets the requirements of ASTM F477. The bell section shall be designed to be at least as hydrostatically strong as the pipe wall.

Fittings shall be either ductile iron as follows:

1. Ductile Iron Fittings: As specified in Section 15062.

   Fittings shall be double wrapped (8 mil) polyethylene encasement, sized to diameter, ANSI/AWWA – C1051/A21.5.

E. Restrained Joint PVC Pipe

1. Pipe shall be manufactured only from water distribution pipe and couplings conforming to AWWA C900. The restrained joint pipe system shall also meet all short and long term pressure test requirements of AWWA C900. Pipe, coupling, and locking splines shall be completely non-metallic to eliminate corrosion problems.

   Nominal outside diameters and wall thicknesses of thrust-restrained pipe shall conform to the requirements of AWWA C900. Pipe shall be Class 150 furnished in standard lengths of 20 feet.

2. Pipe shall be joined using non-metallic couplings which, together, have been designed as an integral system for maximum reliability and interchangeability. High-strength flexible thermoplastic splines shall be inserted into mating precision-machined grooves in the pipe and coupling to provide full 360° restraint with evenly distributed loading. MJ Gland Adapters shall be used to anchor this restrained-joint PVC pipe to ductile iron accessories such as fittings and valves.

3. Pipe shall be blue for potable and non-potable water services (WN), purple for reclaimed water service (FE) and green for other sewer/wastewater service.

4. Restrained joint PVC pipe and fittings shall be Eagle Loc 900 (Class 235, DR 18), Diamond Lok-21 (Class 235, DR 18), or approved equal.

5. Where not indicated on the plans, pipe shall be Class 305, DR 14.

2.02 PVC GRAVITY PIPE

A. General: Pipe and fittings shall be made of PVC plastic having a cell classification of 12454-B as defined in ASTMD 1784 and shall have a SDR and minimum pipe stiffness as scheduled below. T-1 wall only is allowed. Additives and filters including but not limited to stabilizers, antioxidants, lubricants, colorants, etc., shall not exceed 10 parts by weight per 100 of PVC resin in the compound.

1. Markings: Each standard length of pipe and fitting shall be clearly marked with the following:

a. Manufacturer's name

b. Nominal pipe size

c. Cell classification or material code

d. Product type

e. Standard specification designation

f. Production code

B. Pipe: PVC gravity sewer pipe and fittings shall conform to ASTMD 3034 for diameters from 4-inches to 15-inches, and ASTM F679 for diameters from 18-inches to 30-inches, with integral-bell gasketed joints. Rubber gaskets shall be factory installed and conform to ASTM F 477. Pipe joints shall conform to ASTM D 3212. Pipe shall be solid wall only, profile wall pipe is not allowed. Pipe

thickness class shall be SDR-26 pipe.

2.03 CPVC PIPE

A. CPVC material for pipe and fittings shall conform to ASTM D1784, Class 23447-B. Pipe and fittings shall be in accordance with ASTM F441. Neoprene gaskets with push-on joints shall conform to ASTM F477.

B. Schedule 80 CPVC socket type fittings shall conform to ASTM F439. CPVC solvent weld cement for socket connections shall meet the requirements of ASTM F493. Schedule 80 CPVC threaded type fittings shall conform to ASTM F437.

2.04 ABS PIPE

A. Where allowed by code, ABS pipe is allowed for gravity waste and vent piping, 3 inches or less, unless noted otherwise on the drawings.

B. ABS pipe shall conform to ASTM D2661 or ASTM F628.

C. ABS pipe shall be installed per manufacturers recommendations.

2.05 SUBSURFACE DRAINS

Pipe and fittings shall be rigid, corrugated tubing manufactured of high-density polyethylene resins and conforming to ASTM Product Specifications F-405 and F-667. Drainage tubing shall be as manufactured by Advanced Drainage Systems (ADS), Inc., of Columbus, Ohio.

i. Perforated Pipe: Perforations shall be linear slots cut radially into the tubing wall between corrugations. Perforated pipe shall be 6 inches. The screen will completely surround the pipe and will have a lapped, welded longitudinal joint.

ii. Fittings: All couplings, reducers, tees, ells, plugs, caps, and other fittings shall be non-perforated and shall be of the same manufacturer as the drainage tubing. A fitting shall be used at each pipe junction/termination, as appropriate.

PART 3: EXECUTION

3.01 INSTALLATION OF PIPE AND FITTINGS

A. General: In accordance with manufacturer's recommendations, ASTM 2321 and Section 15010, whichever is more stringent.

B. Pipe and fittings shall be of the sizes indicated. Clean pipe interior of all foreign matter before installing. Pipe shall be square cut with fine tooth saw or other cutter or knife designed for use with plastic pipe. Remove burrs by smoothing edges with

a knife, file, or sandpaper. Replace any section of pipe found to be defective or damaged with new acceptable pipe. Handle pipe carefully to prevent gouging or scratching. Any length of pipe having a gouge, scratch, or other permanent indentation more than 10 percent of the wall thickness in depth shall be rejected.

C. PVC pressure pipe shall be laid in standard lengths of 20 feet.

D. Warning tape and tracer wire shall be installed as indicated on the Standard Drawings.

3.02 INSTALLATION OF SOLVENT WELD JOINT TYPE PIPE

In accordance with the recommendations of the pipe manufacturer and the following supplementary requirements:

A. Do not solvent weld joints if it is raining, if atmospheric temperature is below 40 degrees F or above 90 degrees F, if the pipe is exposed to direct sunlight.

B. Test fit dry pipe and fittings before applying cement. Pipe should enter socket without forcing at least one-third but not more than two-thirds the depth of socket. Fittings that are looser or tighter shall not be used. Thoroughly clean and dry the pipe end and socket of fitting with methyl ethyl ketone, acetone, or similar cleaner. Apply cement evenly to outside surface and end of pipe and inside surface of socket. Avoid excess application of cement but insure complete coverage of all bonding surfaces. Mark depth of socket on pipe to guide application of cement and insure full insertion of pipe. Insert pipe in socket, twisting pipe or fitting approximately ½ turn as pipe is being seated in socket. Make sure pipe is fully seated providing a bond between end of pipe and shoulder of socket. Immediately wipe excess cement from pipe leaving no more than a 1/8-inch fillet at fitting end. Hold assembled joint in place for approximately 15 seconds and allow to set for 30 minutes before moving. Avoid rough handling for 48 hours. Longer periods may be required in cold or wet weather.

3.03 INSTALLATION OF PUSH-ON JOINT TYPE PIPE

Clean gaskets and seats of foreign materials prior to joint assembly. Apply lubricant as recommended by the pipe manufacturer. Carefully insert the spigot end into the bell to prevent entry of dirt and incorrect entry angle. With suitable fork tool, crowbar, or by hand, make the joint to the insertion depth recommended by the manufacturer. When the selected pipe uses joints not designed for full depth insertion, prevent further closure of previously completed joints by restraining movement of the installed line while making succeeding joints.

3.04 TESTING

A. Pressure Testing: Shall be in accordance with Section 01667 and 15010.

B. Field Inspection for Plastic Pipe and Fittings: Installed pipe shall be tested to ensure that vertical deflections for plastic pipe do not exceed the maximum allowable deflection. All SDR 26 and 35 PVC Sewer Pipe shall be mandrel tested as outlined below. All C905 PVC pipe may be measured by the Engineer for overdeflection above 3%. Maximum allowable deflections for SDR 26 and 35 pipe shall be governed by the mandrel requirements stated herein and shall nominally be the percentage listed of the maximum average ID.

Nominal Pipe Size	Percentage
Up to and including 12-inch	5.0
Over 12-inch to and including 30-inch	4.0
Over 30-inch	3.0

The maximum average ID shall be equal to the average OD per applicable ASTM Standard minus two minimum wall thicknesses per applicable ASTM Standards. Manufacturing and other tolerances shall not be considered for determining maximum allowable deflections.

Deflection tests shall be performed not sooner than 30 days after completion of placement and densification of backfill. The pipe shall be cleaned and inspected for offsets and obstructions prior to testing.

For all pipes less than 24-inch ID, a rigid mandrel shall be pulled through the pipe by hand to ensure that maximum allowable deflections have not been exceeded. Prior to use, the mandrel shall be certified by the Engineer. Use of an uncertified mandrel or mandrel altered or modified after certification will invalidate the test. If the mandrel fails to pass, the pipe will be deemed to be overdeflected.

Unless otherwise permitted by the Engineer any overdeflected pipe shall be uncovered and, if not damaged, reinstalled. Damaged pipe shall not be reinstalled, but shall be removed from the Work site. Any pipe subjected to any method or process other than removal, which attempts, even successfully, to reduce or cure any overdeflection, shall be uncovered, removed from the Work site and replaced with new pipe.

The mandrel shall:

1. Be rigid, non-adjustable, odd-numbering-leg (9 legs minimum) mandrel having an effective length not less than its nominal diameter.

2. Have a minimum diameter at any point along the full length as follows:

Pipe Material	Nominal Size (inches)	Minimum Mandrel Diameter * (inches)
PVC-ASTM D 3033 (SDR 35)	6	5.619
	8	7.309
	10	9.137
	12	10.963
	15	13.849
PVC-ASTM F 679 (T-1 Wall)	18	16.924
	21	19.952
	24	22.446
	27	25.297
	30	28.502
	36	35.03

* Mandrel diameters of SDR 26 pipe shall be based on 4% deflection of the average inside diameter.

3. Be fabricated of steel, be fitted with pulling rings at each end, be stamped or engraved on some segment other than a runner indicating the pipe material specification, nominal size and mandrel OD, (e.g., PVC D 3034-8"-7.524"; and be furnished in a suitable carrying case labeled with the same data as stamped or engraved on the mandrel.

For pipe IDs nominally 24-inch and larger, deflections shall be determined by a method submitted to and approved by the Engineer. If a mandrel is selected, the minimum diameter, length and other requirements shall conform to the dimensions and requirements as stated above.

All costs incurred by the Contractor attributable to mandrel and deflection testing, including any delays, shall be borne by the Contractor at no cost to the Owner.

END OF SECTION

SECTION 15080

PIPING ACCESSORIES AND APPURTENANCES

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of providing piping accessories and appurtenances.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15010: General Process and Onsite Utility Piping Provisions

1.03 QUALITY ASSURANCE

Reference, American Society for Testing and Materials (ASTM).

1.04 SUBMITTALS

Materials list and catalog data sheets naming each product to be used identified by manufacturer and type number.

PART 2: MATERIALS

2.01 FLEXIBLE COUPLINGS

A. Application

	Baker	Smith-Blair	Dresser
Iron pipe size O.D. pipe	200	411	38,90
Ductile iron	228	411, 431, 441	38, 53, 138, 153
Transition	212	413, 433	162
Reducing	220	415, 435	62
Flanged coupling adapter	602, 603	912, 913, 914	127, 128

Rockwell International, 400 North Lexington, Pittsburg, PA 15208; Dresser Mfg., 41 Fisher Ave., Bradford, PA 16701; R.H. Baker & Co., 2929 Santa Fe Ave., Los Angeles, CA 90058, or equal.

B. Materials

Cast couplings shall be used wherever possible. Steel couplings with a minimum

sleeve thickness of the connecting pipe wall or ¼-inch, whichever is greater, shall be used where cast couplings are not available.

1. Sleeve: Grey iron or steel.

2. Flanges: Malleable or ductile iron or high strength steel.

3. Bolts & Nuts: Low alloy, high strength, zinc coated when exposed, 316 stainless steel when buried or below top of wall in water bearing structures.

4. Finish of coupling: Fusion bonded epoxy coating.

5. Gaskets

   a. General Purpose - Synthetic rubber (Rockwell grade 60, Dresser 42). Non-asbestos gasket for service above 180°F.

   b. High Temperature Service – Gaskets on air piping (AE and AA service) shall be suitable for temperatures up to 300°F.

2.02 FLEXIBLE RUBBER COUPLINGS

A. Type: Molded single arch spherical rubber expansion joints with full rubber flanges and retainer rings.

B. Materials

1. General Service (less than 225°F) - Neoprene with nylon reinforced body and galvanized steel retainer rings and fasteners.

2. High Temperature Air Service (greater than 225°F) – EPDM with nylon reinforced body and galvanized steel retainer rings.

C. Pressure Rating: 150 psi.

D. Manufacturer: General Rubber Style 1015, or equal.

2.03 FLEXIBLE METAL HOSE CONNECTORS

A. NPT Union or 150 pound flanged end connections.

B. Type 321 stainless steel hose and braid.

C. Minimum 200 steady working pressure at room temperature, safety factor of 4:1.

D. Anaconda Metal Hose Type PCM or SPCF, 18518 Susana Rd., Compton, California 90221, Flexonics MMT or FLG, 300 East Devon Ave., Bartlett, IL 60103, or equal.

2.04 TENSION ASSEMBLIES

A. Welded

1. Assemblies per AWWA M11, Section 13.10

2. Rods shall be galvanized.

3. Buried assemblies shall receive two coats Bitumastic 50, Koppers, or equal.

B. Socket Clamps

1. Carbon steel half bands, bolts and nuts, galvanized.

2. Socket clamps, Grinnell Fig. 595, B-Line Systems Fig. B3134, or equal.

3. Socket clamp washers, Grinnell Fig. 594, B-Line Fig. B3134W, or equal.

4. Yoke, Grinnell Fig. 591.

5. Tee anchor strap, Grinnell Fig. 593, or equal.

6. Buried assemblies shall receive two coats Bitumastic 50, Koppers, or equal.

7. Grinnell Corporation, 155 Westminster Street, Providence, RI 02903; B-Line Systems, 509 West Monroe St., Highland, IL 62249, or equal.

2.05 MECHANICAL RUBBER SEAL

A. Modular, mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.

B. EPDM seal element suitable for service to 250°F.

C. Composite pressure plates.

D. 316 stainless steel nuts and bolts.

E. Thunderline Link-Seal, or equal.

2.06 INSULATED (DIELECTRIC) FITTINGS

A. General

Provide complete insulation between sections of pipe in which installed. All buried pipelines of dissimilar metals shall be insulated from each other.

B. Couplings and Bushings

1. Made of Delrin for sizes less than 2-inches, Calpico, Inc.,185 Harbor, South San Francisco, California 94080; Pacific Seal Industries, 3333 N. San Fernando Blvd., Burbank, California 91504, or equal.

2. Heavy duty couplings with insulating linings for 2-inch and larger, Rockwell 416 and 438, Dresser 39 or equal.

C. Flanges

1. Assembly consisting of gaskets, insulating bolt sleeves, and appurtenances.

2. Pacific Seal Industries; Calpico, Inc.; or equal.

2.07 PRESSURE GAUGES (PG)

A. Liquid filled, glycerine or silicone.

B. 2½- to 3½-inch dial, scale 20-50% greater than normal operating pressure, 270 degree movement.

C. Stainless steel case and polycarbonate window.

D. Provide gauges with Type 316 stainless steel socket and bellows or bourdon tube, depending on pressure range.

1. Where the maximum pressure is less than or equal to 15 pounds per square inch the gauge shall use bellows as the measuring element.

2. Where the maximum pressure is greater than 15 pounds per square inch, the measuring element shall be a bourdon tube.

E. 2½ percent accuracy.

F. ¼-inch NPT bottom connection.

G. Mount gauges on diaphragm seals where indicated on the Drawings.

1. Provide diaphragm seals with Type 316 stainless steel top housing, bottom housing, and bolt assemblies.

a. Bottom housing shall be fitted with a ¼-inch flushing connection.

b. This flushing connection shall be fitted with a Type 316 stainless steel close nipple and a brass shutoff cock.

c. Diaphragm Seal: Removable.

1) For pressure less than or equal to 15 pounds per square inch, provide a diaphragm seal.

2) For pressures greater than 15 pounds per square inch, provide Type 316 stainless steel diaphragm seal.

d. Fit diaphragm seal gauge assembly with a snubber.

e. Snubber shall have porous metal disc sized to dampen pressure fluctuations in the filled system.

f. Snubber shall be Stainless Steel.

g. Snubber filter disc shall be sized to prevent the gauge from pulsating.

h. Provide diaphragm seal gauge assemblies filled with silicon.

2. Pressure gauges, except gauges with diaphragm seals, shall have pulsation dampeners installed between the gauge and the shut-off valve.

3. Pulsation Dampeners shall be Stainless Steel.

H. Manufacturers

1. PRESSURE GAUGES: One of the following or equal:

a. U.S. Gauge Division of Ametek, Inc. Solfrunt Gauges, Figure Number 1931T.

b. Dresser Industries, Inc., Ashcroft Figure Number 1379.

2. DIAPHRAGM SEAL: One of the following or equal:

a. For pressure less than or equal to 15 pounds per square inch:

b. Ashcroft, Type 301.

c. Mansfield and Green, Type LG.

d. For pressures greater than 15 pounds per square inch:

e. Ashcroft, Type 101.

f. Mansfield and Green, Type RG.

3. Snubber: One of the following or equal:

Chemiquip, Ashcroft

4. Pulsation Dampeners: One of the following or equal:

a. Dresser Industries, Inc., Ashcroft Figure Number 1106S.

b. Operation and Maintenance Specialties, Charlotte, N. C., Ray Pressure Snubbers.

5. ¼-inch stainless steel cross handle cock, Ashcroft 7004; Marsh MFG, or equal.

2.08 LINE SIZE PRESSURE SENSORS

A. Full line size with flanged or threaded ends

B. Carbon steel body with flexible neoprene tube and liquid cavity.

C. Rated at 200 psi with 2 percent accuracy.

D. Gauge and liquid as specified in subsection 2.11 above.

E. Red Valve Series 30 or 40, 500 No. Bell Ave., Carnegie, PA 15106; Ronningen-Petter "Iso-Spool" or "Iso-Ring", Portage, MI 49081, or equal.

2.09 PIPELINE STRAINERS

A. 2-inches and smaller

1. Y-pattern.

2. Bronze or cast iron body.

3. 316 Stainless steel or monel screen, .045-inch perforations, 4 to 1 straining ratio.

4. Blowoff connection with bronze ball valve.

5. Muessco Model 11 or 351; Leslie Co., or equal.

B. Simplex Basket Style

1. 8-inch flanged unless otherwise noted on the Drawings.

2. Cast iron body.

3. Stainless steel perforated screen, with a straining area at least 6 times the pipe cross sectional area, perforation size as noted on the Drawings.

4. Quick open cover shall not require tools to remove the basket for cleaning.

5. Machined basket seats, Buna N seals.

6. Threaded drain, vent, and pressure taps as shown on the Drawings.

7. Hayward Industrial Products, Model 72, or equal.

2.10 CURB STOPS

A. Manufacturers: One of the following or equal.

1. Ford

2. Mueller Company

B. Description: Round way solid tee head stops.

2.11 CORPORATION STOPS

A. In accordance with AWWA C 800.

B. Manufacturers: One of the following or equal.

1. Ford

2. Mueller Company

2.12 COCKS

A. Gauge Cock:

Manufacturers: One of the following or equal.

Lunkenheimer Company, Figure 1178 or Figure 1180

B. Air Cock:

Manufacturers: One of the following or equal.

1. Whitey Research Tool Company, Model B-42S4

2. Hoke Inc., 7122G4B

C. Plug Cock Manufacturers: One of the following or equal.

Lunkenheimer Company, Figure 454

D. Design:

Plug Cocks: Bronze, straightway pattern complete with lever.

2.13 PIPE SADDLES

A. Manufacturers: One of the following or equal.

1. Jones J-996 or Ford S912 O.D. controlled (PVC)

2. Romac Style 202NSSU (Ductile Iron)

B. Materials

1. Pipe Saddles: Ductile iron.

2. Straps, Bolts, and Nuts: Type 304 stainless steel with Teflon coating on nuts.

3. Gaskets: EPDM

2.14 Channel Grates

Grates should be securely locked down with built-in channel lock blocks. Locking mechanism shall be designed so as to provide an obstruction-free trench for maintenance and cleaning as well as to prevent concrete from entering channels during installation.

Channel grates shall be installed as scheduled below:

1. Non-corrosive traffic* areas – Ductile iron, slotted, H2O rated.
2. Non-corrosive, pedestrian traffic - slotted, galvanized steel.
3. Corrosive traffic* areas - vinyl ester, slotted, load Class C.
4. Corrosive pedestrian traffic – vinyl ester slotted.

*Traffic includes fork lift travel.

Areas normally wet shall be considered corrosive areas.

2.15 Catch Basins

Catch basins shall be precast polymer concrete with FRP grates. Any trench drains entering catch basins shall interlock fully with tongue and groove connections.

A. Joint Sealers
To prevent leakage, joints between channels, catch basin connections, etc., shall be sealed with an adhesive recommended by the manufacturer.

B. Manufacturer's
Trench drains shall be as manufactured by ACO Polymer Products, Inc., Chagrin Falls, OH, Polydrain ABT, Inc., Troutman, N.C., or equal.

2.16 SIMPLEX BASKET STRAINERS

A. 4-Inch flanged connections, cast iron construction, 150 psi rated.
B. T-handle quick release cover.
C. Basket Strainer: SST 1/32" perforated basket, Cv = 375.
D. Manufacturer: Hayward model 72 or equal.

2.17 FLUSHING CONNECTION

A. Cast bronze swivel inlet adapter, rocker lugs.

B. 1-inch NPT inlet, hose thread outlet.

C. DeSanno Foundry & Machine Co. No. 73, 1933 Peralta, Oakland, CA 94607; Champion No. 10, 1460 No. Naud St., Los Angeles, CA 90012, or equal.

2.18 TAPPING SLEEVES

A. Manufacturers: One of the following or equal.

1. BTR Inc./Smith-Blair, Inc., Style 622

2. Romac Industries, Inc., Style FTS 420

B. Materials:

1. Tapping Sleeves: Steel construction.

2. Bolts and Nuts: Type 304 stainless steel.

3. Nuts: Teflon coated.

4. Gaskets: EPDM

5. Size of Tapped Boss: As indicated on the Drawings.

PART 3: EXECUTION

3.01 INSTALLATION

Install in accordance with manufacturer's recommendations.

3.02 FLEXIBLE COUPLINGS

A. Install where shown on Drawings and where required for ease of installation or removal of pipe, subject to approval of Engineer.

B. Provide tension assemblies as specified in herein where necessary to prevent separation of pipe due to internal pressures.

END OF SECTION

SECTION 15094

HANGERS AND SUPPORTS

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of providing necessary materials and installation to properly support all pipe, electrical conduit, ductwork and miscellaneous hardware.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Section 11010: General Mechanical Equipment Provisions

C. Section 15010: General Process and Onsite Piping Provisions

1.03 QUALITY ASSURANCE

Standards

AA	Aluminum Association
AISC	American Institute of Steel Construction
ASTM	American Society for Testing and Materials
AWS	American Welding Society.

1.04 SUBMITTALS

A. In accordance with Section 01300.

B. Shop Drawings: Submit certified drawings showing all details of pipe, electrical conduit, ductwork and miscellaneous support devices. Shop drawings shall include all details of construction, anchor size, hanger rod sizes, bar sizes, weld sizes, mounting dimensions and overall space requirements.

C. Manufacturer's Literature: Submit manufacturer's literature for all channels, clevis hooks, straps, hanger rod, anchors, fasteners, and related material used in the utility support systems.

PART 2: MATERIALS

2.01 HANGERS AND SUPPORTS

A. Hangers and supports shall be factory fabricated units with published load limits and meet Manufacturer's Standardization Society of the Valve and Fittings Industry

Standard Practice SP58.

B. Provide hanger or support as indicated on drawings, or select an appropriate hanger or support as shown on the "PIPE SUPPORT DETAILS" Drawing.

C. Pipe Hangers and supports

1. Type 1 – Clevis Pipe Hanger, configuration and components equivalent to MSS and FEDSPEC Type 1.

    a. Steel pipe (insulated): B-Line B3100, Anvil International 260, or equal, with insulation shield.

    b. Steel pipe (uninsulated): B-Line B3100, Anvil International 260, or equal.

    c. Cast and ductile iron pipe: B-Line B3102, Anvil International 590, or equal.

    d. Copper pipe (uninsulated): B-Line B3104 CT, Anvil International CT-65, or equal.

    e. Copper pipe (insulated): B-Line B3100, Anvil International 260, or equal, with insulation shield.

    f. Plastic pipe: B-Line B3100 C, Carpenter & Patterson Fig. 100PVC, or equal.

2. Type 2 – J Pipe Hanger, configuration and components equivalent to MSS Type 5

    a. Steel pipe: B-Line B3690, Anvil International 67, Michigan model 418, or equal.

    b. Copper and plastic pipe: Michigan model 419, Unistrut J 1205N series, or equal.

3. Type 3 – Double Bolt Pipe Clamp, configuration and components equivalent to MSS and FEDSPEC Type 3.

    a. Steel pipe (insulated): B-Line B3144, Anvil International 295, or equal, with insulation shield. Insulation shield is optional for hot and ambient systems.

    b. Steel pipe (uninsulated): B-Line B3144, Anvil International 295, or equal.

    c. Copper pipe (insulated only): B-Line B3144, Anvil International 295, or equal, with insulation shield.

4. Type 4 – Adjustable Roller Hanger, configuration and components equivalent to MSS Type 43 and FEDSPEC Type 44.

    a. Steel pipe (insulated): B-Line B3110, Anvil International 181, or equal, with insulation shield.

    b. Steel pipe (uninsulated): B-Line B3110, Anvil International 181, or equal.

    c. Copper pipe (insulated only): B-Line B3110, Anvil International 181, or equal, with insulation shield.

    d. Plastic pipe: B-Line B3110, Anvil International 181, or equal.

5. Type 5 – Single Pipe Roll, configuration and components shall be equivalent to MSS Type 41 and FEDSPEC Type 42.

    a. Steel pipe (insulated): B-Line B3114, Anvil International 171, or equal, with insulation shield.

    b. Steel pipe (uninsulated): B-Line B3114, Anvil International 171, or equal.

    c. Plastic pipe: B-Line B3114, Anvil International 171, or equal.

6. Type 6 – Framing Channel Pipe Clamp

    a. Steel pipe (uninsulated):

        1. Pipe size 3/8” and 1/2”: 16-gage;

        2. 3/4” through 1 1/4”: 14 gage;

        3. 1-1/2” through 3”: 12-gage;

        4. 3 1/2” through 5”: 11- gage;

        5. 6 and 8”: 10-gage;

    b. Michigan Model 431, Powerstrut PS 1100, Unistrut P 1109 series, or equal.

    c. Steel pipe (insulated): Pipe clamp as described in Paragraph 2.02 B.6.a with insulation shield.

    d. Copper (uninsulated) and plastic pipe:

        1. Pipe size 3/8” and 1”: 16-gage;

        2. 1-1/4” and 1-1/2”: 14-gage;

3. 2” through 3”: 12-gage;

4. 4”: 11-gage;

5. Clamp: copper-plated, plastic coated or lined with dielectric material;

6. Michigan model 432, Powerstrut PS 1200, Unistrut P 2024C and P 2024PC series, or equal.

e. Copper pipe (insulated): Pipe clamp shall be as described in Paragraph 2.02 B.6.a with insulation shield.

7. Type 7 – U-Bolt Configuration equivalent to MSS and FEDSPEC Type 24.

a. Steel pipe (uninsulated): Anvil International. 137, B-Line B3188, or equal.

b. Steel pipe (insulated): Anvil International. 137, B-Line B3188, or equal, with insulation shield.

c. Cast and ductile iron pipe: Anvil International. 137, B-Line B3188, or equal.

d. Copper pipe (uninsulated): Carpenter & Patterson Fig. 222 CT, B- Line B3501 CT, Anvil International. 137C, or equal.

e. Copper pipe (insulated): Anvil International. 137, B-Line B3188, or equal, with insulation shield.

f. Plastic pipe: Anvil International. 137C, Michigan model 151,

B-Line B3188 C, or equal.

8. Type 8 – Adjustable Pipe Roll Support

a. Steel pipe (insulated): B-Line B3122, Anvil International. 177, or equal, with insulation shield.

b. Steel pipe (uninsulated): B-Line B3122, Anvil International. 177, or equal.

c. Copper pipe (insulated only): B-Line B3122, Anvil International. 177, or equal, with insulation shield.

d. Plastic pipe: B-Line B3122, Anvil International. 177, or equal.

9. Type 9 – Welded Pipe Stanchion

a. Minimum material thickness: standard schedule pipe, cut to match contour of the pipe elbow.

b. Limit use of this support to ambient systems only.

10. Type 10 – Pipe Stanchion Saddle and Yoke, comply with MSS Type 37 and FEDSPEC Type 38.

a. Steel pipe (insulated): Carpenter & Patterson Fig. 125, B-LineB3090, or equal, with insulation shield.

b. Steel pipe (uninsulated): Carpenter & Patterson Fig. 125, B-Line B3090, or equal.

c. Cast and ductile iron pipe: Carpenter & Patterson Fig. 125, B-Line B3090 NS, or equal.

d. Copper pipe (uninsulated): Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield or lined with dielectric material.

e. Copper pipe (insulated): Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.

f. Plastic pipe: Carpenter & Patterson Fig. 125, B-Line B3090, or equal.

11. Type 11 – Offset Pipe Clamp, Provided with configuration and components specified using standard designs offered by a pipe hanger component manufacturer.

a. Steel pipe (insulated): B-Line B3148, Anvil International 103, or equal, with insulation shield.

b. Steel pipe (uninsulated): B-Line B3148, Anvil International 103, or equal.

c. Cast and ductile iron pipe: B-Line B3148 NS, Anvil International 103, or equal.

d. Copper pipe (insulated): B-Line B3148, Anvil International. 103, or equal, with insulation shield.

e. Copper pipe (uninsulated): B-Line B3148, Anvil International. 103, or equal, lined with dielectric material.

f. Plastic pipe: B-Line B3148, Anvil International. 103, or equal.

g. Vertical pipe support applications: as specified above except do not use insulation shields for insulated pipe.

12. Type 12 – Riser Clamp, configuration and components equivalent to MSS and FEDSPEC Type 8.

h. Steel pipe (insulated): B-Line B3373, Anvil International 261, or equal.

i. Steel pipe (uninsulated): B-Line B3373, Anvil International 261, or equal.

j. Cast and ductile iron pipe: B-Line B3373, Anvil International 261, or equal.

k. Copper pipe (insulated): B-Line B3373 CT, Anvil International CT-121, Michigan model 511, or equal.

l. Copper pipe (uninsulated): B-Line B3373 CT, Anvil International CT-121, Michigan model 511, or equal.

m. Plastic pipe: B-Line B3373, Anvil International. 261c, or equal.

13. Type 13 – Framing Channel Pipe Strap, configuration equivalent to MSS Type 26.

a. Steel pipe (uninsulated): Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

b. Steel pipe (insulated): Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

c. Copper pipe (uninsulated): Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield or lined with dielectric material.

d. Copper pipe (insulated): Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

e. Plastic pipe: Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

D. Rack and Trapeze Supports

1. General

a. Unless otherwise specified, provide trapeze and pipe rack components minimum thickness of 12 gage, with a maximum deflection 1/240 of the span.

2. Type 20 – Trapeze Pipe Support

a. For trapeze pipe support cross members, use framing channel as specified in Paragraph 2.02 E.5. For flat plate fittings, 1-5/8" square standard design manufactured by framing channel manufacturer, Unistrut P2471, B-Line B202-2, or equal.

3. Type 21 – Pipe Rack Support

a. For post and cross members, use framing channel as specified in Paragraph 2.02 E.5. For pipe rack fittings, use standard design manufactured by framing channel manufacturer. For 90º fittings, use gusseted Unistrut P2484, B-Line B844, or equal. Provide post base fittings as specified in Paragraph 2.02 D.5.

E. Structural Attachments

1. Type A –Insert For Concrete:

a. Concrete inserts: Comply with MSS and FEDSPEC Type 18.

b. Anvil International 282, Carpenter & Patterson Fig. 108, or equal.

2. Type B – Side Beam Bracket

a. Comply with MSS Type 34 and FEDSPEC Type35.

b. Anvil International. 202, B-Line B3062, or equal.

3. Type C –Beam Clamp with Extension Piece

a. Comply with MSS and FEDSPEC Type 30.

b. Anvil International. 218 with Fig. 157 extension piece, B-Line B3054, or equal.

4. Type D – Beam Clamp with Eye Nut

a. Beam clamp and eye nut: forged stainless steel.

b. For configuration and components, comply with MSS and FEDSPEC Type 28.

c. Anvil International. 292, Carpenter & Patterson Fig. 297, or equal.

5. Type E – Framing Channel Post Base

    a. Standard design offered by framing channel manufacturer.

    b. Single channel: Unistrut P2072A, B-Line B280, or equal.

    c. Double channel: Unistrut P2073A, B-Line B281, or equal.

6. Type F – Welded Beam Attachment

    a. Comply with MSS and FEDSPEC Type 22. B-Line B3083, Anvil International. 66, or equal.

7. Type G – Welded Steel Bracket

    a. Comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket.

    b. Comply with MSS Type 33 and FEDSPEC Type 34 for heavy welded bracket.

8. Type H –Bracket

    a. Carpenter & Patterson Fig. 340, or equal.

9. Type J – Adjustable Beam Attachment

    a. Carpenter & Patterson Fig. 151, B-Line B3082, or equal.

10. Type K – Double Channel Bracket

    a. Wall channel: single channel framing channel as specified in Paragraph 2.02 E.5.

    b. Cantilever bracket: double framing channel assembly, Unistrut P2542 through P2546, B-Line B297-12 through B297-36, or equal.

11. Type L – Single Channel Bracket

    a. Wall channel: single channel framing channel as specified in Paragraph 2.02 E.5.

b. Cantilever bracket: a single framing channel assembly, Unistrut P2231 through P2234, B-Line B198-6, B198-12, B196-18 and B196-24, or equal.

12. Type M – Wall Mounted Channel

a. Wall channel: single channel framing channel as specified in Paragraph 2.02 E.5.

13. Type N – Pipe Stanchion Floor Attachment

a. Base plate: 1/2" minimum thickness.

b. Make anchor bolt holes 1/16" larger than the anchor bolt diameter.

c. Fill space between the base plate and the floor with nonshrink grout.

F. Accessories

1. Hanger Rods

a. Rods: threaded on both ends or continuous threaded and sized as specified.

2. Weldless Eye Nut

a. Eye nut: forged stainless steel and complying with MSS and FEDSPEC Type 17.

b. Manufacturer: Anvil International. 290, B-Line B3200, or equal.

3. Welded Eye Rod

a. Weld-eye rod closed. Make inside diameter of eye a bolt diameter 1/8" larger than the rod diameter.

b. Manufacturer: Anvil International. 278, B-Line B3211, or equal.

4. Turnbuckle

a. Turnbuckle: forged stainless steel and complying with MSS and FEDSPEC Type 13.

b. Manufacturer: Anvil International. 230, B-Line B3202, or equal.

5. Framing Channel

a. Framing channel: 1-5/8" square, roll formed, 12-gage.

b. Provide channel with a continuous slot along one side with in-turned clamping ridges.

c. Single channel: Unistrut P1000, B-Line B22, or equal.

d. Double channel: Unistrut P1001, B-Line B22A, or equal.

e. Triple channel: Unistrut P1004A, B-Line B22X, or equal.

2.02 FRAMING SUPPORT SYSTEMS

A. As called out on the drawings and as required to provide adequate support, use framing systems as manufactured by B-Line Systems, Highland, IL 62249; Unistrut Corporation of Wayne, MI 48184; or equal.

B. The load capacities of parts, connections and assemblies shall meet or exceed those published in the latest framing manufacturer's engineering catalog and supplementary bulletins.

C. All framing members and fittings in non-corrosive or dry areas shall be hot-dipped galvanized steel or painted as noted below. Nuts and screws shall be electro-galvanized. All painted channels and fittings shall be carefully cleaned and phosphated. Immediately after phosphating, a uniform coat of highly effective rust inhibiting acrylic enamel paint shall be applied by the electro-deposition process and thoroughly baked. Color shall be Unistrut "Perma-Green", B-Line "Dura-Green per Federal Standard 595a, color number 14109 (dark limit V-).The resulting finish will withstand 400 hours salt spray when tested in accordance with ASTM designation B-117.

D. All framing members and fittings for humid, wet or corrosive areas shall be stainless steel or fiberglass. Cut ends of fiberglass shall be sealed per manufacturer’s recommendations. Nuts and screws shall be stainless steel, fiberglass or nylon as approved by the Engineer.

E. Continuous insert embedment channel shall be B-Line B52I; Unistrut P-3300 Series, Caine Strut No. C-3450/70, or equal.

2.03 CABLE TRAYS

Shall be B-Line Series 444; Unistrut tray system 3L2 Series, Globetray HDS Series, in widths as shown on the Drawings and with 18-inch rung spacing. Tray shall be supported on six foot maximum centers and designed to support a safe uniform allowable load of 200 pounds per lineal foot. Side rails shall be 3- or 4-inch high, 0.0747" (14 gauge) galvanized steel.

2.04 MISCELLANEOUS METAL FABRICATIONS

As specified in Section 05500. All miscellaneous metals used for hangers and supports

shall be hot-dip galvanized in accordance with ASTM A123. Vent holes shall be provided in closed tube type members in an unobtrusive location as required to prevent any danger of explosion during the galvanizing process.

PART 3: EXECUTION

3.01 PIPE SUPPORTS AND HANGERS

A. General:

1. Pipes and ductwork shall be supported as shown on the Drawings, otherwise use appropriate type of support.

2. Supports shall be used to meet all criteria herein, regardless of whether or not indicated on the drawings. No pipe shall be left unsupported whenever a change in direction of line or flow takes place. At least one support shall be provided between every two couplings. Supports shall be provided for all valves, meters, or other metallic appurtenances.

3. Securely fasten all piping to building construction with approved iron hangers, supports, guides, anchors and sway braces to maintain pipe alignment and prevent sagging, noise and excessive strain due to uncontrolled movement under operating conditions.

4. Relocate any hangers as necessary to correct unsatisfactory conditions that may become evident when system is put into operation.

5. Supporting of piping by wire, rope, wood or other makeshift devices will not be permitted.

6. Burning of holes in beam flanges or narrow members will not be permitted.

7. Sway bracing of non-resiliently supported piping shall be in accordance with SMACNA Guidelines for Seismic Restraint of Mechanical Systems, except that fire protection piping shall be supported per NFPA requirements.

8. Fasten hanger rods to structural steel members with suitable beam clamps.

9. Protect pipe insulation at every hanger, support or guide of insulated piping with inserts and shields.

10. Where supported by pipe hangers from the ceiling or where lateral displacement of pipe is probable, pipelines shall be seismically braced laterally at every 20 feet, and braced longitudinally and laterally every 40 feet and at 90 degree bends. The seismic bracing shall consist of 3/8-inch steel plate welded to pipe hanger, ½-inch diameter all threaded rod, ½-inch diameter flexible connector and eye rod inserted in the ceiling.

11. Piping within equipment rooms shall be vibrationally isolated and

restrained by a Seismic Restraint System.

B. Manifolding:

1. Parallel runs of piping, except for fire protection piping may be supported on trapeze hangers, spaced as required for the smallest pipe carried.

2. Piping in chases shall be supported on channel framing.

3. Channel framing shall be selected to support 5 times the weight or thrust of the piping without failure in accordance with the manufacturer's standard ratings. Submit details for approval.

C. Support Hanger Spacing:

1. Maximum spacing for horizontal piping supports shall be as follows:

MATERIAL	SIZE	SPACING
Steel Pipe and Stainless Steel Pipe	1” and smaller	5 feet
	1-1/4” to 2”	7 feet
	Larger than 2”	10 feet
Copper Pipe	1" and smaller	5 feet
	1-1/4" and larger	8 feet
PVC Pipe	1" and smaller	4 feet
	1-1/4" to 2"	4-1/2 feet
	2-1/2" to 3-1/2"	5 feet
	4" to 5"	6 feet
	6" and larger	7 feet
Ductile iron pipe	All sizes	8 feet
Fiberglass pipe	Less than 3"	8 feet
	3" and larger	10 feet

2. Where building structure does not permit the specified spacing the Contractor shall provide additional adequate support. Location and details shall be submitted for approval.

3.02 ELECTRICAL CONDUIT SUPPORT

See Division 16 for additional requirements

3.03 DUCTWORK SUPPORT

The support type detail used will be as shown on the drawings. The spacing and frequency

of support details will be as required by the latest SMACNA guide.

3.04 MISCELLANEOUS HARDWARE

Support as shown. When not shown, support as required to form a solid, rigid, strong installation satisfactory to the Engineer.

3.05 GALVANIZING TOUCH-UP

Cold Galvanize all field cut bare metal not designated to be painted.

END OF SECTION

SECTION 15100

VALVES

PART 1: GENERAL

1.01 DESCRIPTION

The work of this section consists of furnishing and installing valves used to throttle, isolate, and control flow in piping systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300: Submittals

B. Division 15: Piping Materials

1.03 QUALITY ASSURANCE

Reference, American Society for Testing and Materials (ASTM)

1.04 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300.

B. Materials list and catalog data sheets naming each product to be used identified by manufacturer and type number.

C. Submit Operations and Maintenance Manuals for approval for all valves.

PART 2: MATERIALS

2.01 VALVES - GENERAL

A. All valve construction, materials, and pressure ratings shall be selected to suit the system in which installed. Pressure rating and manufacturer's name shall be cast on each valve body. Where specified, valves shall be supplied fully packed with Teflon impregnated packing. Where possible, valves shall be of one manufacturer.

B. Stems of all bronze valves shall be silicon bronze or similar alloy to prevent de-zincification. Alloy shall have minimum tensile strength of 60,000 psi, minimum yield point of 24,000 psi per ASTM B584.

C. Valves shall be furnished full line size unless specifically called out to be of reduced size. Flanges for valves may be raised or plain face. Flanges for valves for water working pressures of 175 psi or less shall be faced and drilled to 125 lb. standard dimensions.

D. Valves installed immediately adjacent to flanged equipment and flanged specialties shall be flanged, regardless of size.

E. Valves in welded piping shall be flanged, regardless of size.

F. Where valves are designed to have power operators, the operator shall be installed and tested at the factory prior to shipment to the job site.

2.02 GATE VALVES (GTV)

A. 2½ inches and smaller: Mueller; Clow; Stockham B122, or equal with manufacturer's standard bronze, solid wedge disc, rising stem and screwed ends, rated for 200 psi working pressure.

B. 3 inches and larger: non-rising stem, resilient wedge flanged valves with handwheels and shall conform to the requirements of AWWA C509 CLASS C.

C. Buried gate valves 2 inches and larger: non-rising stem, resilient seat valves with 2-inch square operating nut. Valves shall have mechanical joint, hub or flanged ends as required by the nature of the installation and shall conform to the requirements of AWWA C509 Class C. Provide one-piece Schedule 40 galvanized steel pipe extension stems pinned to gate valve stem where operating nut is more than 30" below grade, unless shown otherwise on the Drawings.

D. Manufactures for 3-inches and larger gate valves shall be Mueller. Clow, M&H Style 4067, or equal.

E. All gate valves used for sewer piping shall have type 316 stainless steel riser stems.

2.03 PLUG VALVES (PV)

A. General: Plug valves shall be of the non-lubricated, eccentric-type, rated for 175 psi working pressure for valves 12-inches and smaller and 150 psi for valves 14-inches through 20-inches. Valves 4-inches through 20-inches will have a minimum of 80% port area.

B. Connections: Screwed, flanged, grooved, or mechanical joint as shown on the drawings or required for the installation. Flanges shall be faced and drilled to the requirements of ANSI B16.1, Class 125.

C. Materials:

1. Body: Cast iron, ASTM A-126, Class B.

2. Seat: Welded, 90% pure nickel overlay (1/8-inch minimum).

3. Bearings: Type 316 stainless steel ASTM A743, permanently lubricated.

4. Plug: Cast iron, ASTM A-126, Class B or ASTM A-536 Grade 65-45-12.

5. Plug Facing: Chloroprene Neoprene, Acrylonitrite Butadiene Buna-N, or EPDM.

6. Shaft Seals: Shall be V-ring or U-cup packing that is either externally adjustable or self-adjusting.

D. Operators:

1. Unless otherwise shown or required, operators on exposed valves shall have open and closed position stops, position indicator, type as follows:

a. 3-inches and smaller: fixed lever

b. 4-inches: lever on 2-inch square operating nut

c. 6-inches and larger: enclosed worm gear with handwheel. Maximum 80 lb. rim pull to actuate the valve at its full bi-directional operating pressure.

d. Chainwheel actuators shall be provided where shown on drawings.

2. Unless otherwise shown or required, all buried valves shall have gear operators with 2-inch square nut inputs and shall be sealed against water intrusion. Exposed nuts and bolts on buried actuators shall be stainless steel. Buried valves shall have plugs that open upward. Where shown on the drawings, provide stem extension and above ground gear handwheel operator.

E. Plug Valves shall be Pratt Ballcentric, DeZurik PEC, Val-Matic, M&H Style 1820, Milliken, Victaulic Series 365, or equal.

2.04 CHECK VALVES (CV), (PCV), AND

A. Swing Check Valves (CV) - 2½-inch and smaller: bronze, screwed cap, bronze disc, Y-pattern, 200 psi working pressure, screwed ends. Crane Co. No. 37; Stockham B-319, or equal.

B. Swing Check Valves (CV) - 3-inch and larger: Valves shall have outside lever on side of valve to suit installation and/or be reversible in the field. Valves shall be able to be easily modified in the field to attach cushioning system if required. all swing check gate valves 3-inch and larger suitable for sewage service to have epoxy coated ductile iron body, cover and disc, 250-psi rated, 316ss body seat, buna-n rubber faced ductile iron disc, stainless steel hinge shaft, stainless steel external fasteners. Outside lever and weight, GA Industries Figure 340-W “Ludlow” swing check valve or approved equal.

C. Plastic Check Valves (PCV) - Ball check, PVC Type 1, Grade 1, viton seals, 150 psi at 73°F water, flanged or true union ends. Chemtrol BC series; Hills-McCanna "McCannaplast", or equal. Or true union.

2.05 FLEXIBLE CHECK VALVES (FCV), (FSCV)

A. Flexible Check Valve:

1. All rubber, flow operated with integral elastomer flange. Inlet port area 100% of mating pipe port size. Port area shall contour down to a duckbill which shall allow passage of flow in one direction while preventing reverse flow. The flexible duckbill sleeve shall be one-piece rubber construction with fabric reinforcement and have a protective EPDM exterior wrapping for protection against sunlight.

2. Red Valve Co. series 35 (similar to "Tide-Flex"), or equal.

B. Flexible Swing Check Valve:

1. The check valve shall be of the flexible type, full body flanged type, with a domed access cover and only one moving part, the valve disc.

2. The valve body shall have full flow equal to nominal pipe diameter at any point, through the valve. The seating surface shall be on a 45 degree angle to minimize disc travel. The top access port shall be full size, allowing removal of the disc without removing the valve from the pipeline. The access cover shall be domed in shape, to allow the disc to be fully operational in lines containing a high solids content.

3. The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface and contain steel and nylon reinforcements in both the arm and central disc areas. The flex portion of the disc shall be warranted for twenty-five years. Non-slam closing characteristic shall be provided through a short 35 degree disc stroke and a flexible disc return action.

4. The valve body and cover shall be ASTM A126, Class B cast iron. The disc shall be Buna-N (NBR), ASTM D2000-BG.

5. The interior of the valve shall be coated with an epoxy suitable for portable water. The exterior shall be coated with a universal primer.

6. The valve shall be cycle tested 1,000,000 times with no signs of wear or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. The tests results shall be independently certified.

7. The valve shall be series 500 as manufactured by Val-Matic Valve and Manufacturing Corporation, APCO, or approved equal.

2.06 BALL CHECK VALVES FOR SUBMERSIBLE PUMPS (BCV)

A. Suitable for handling sewage and installed as shown on the Drawings.

B. Cast iron body, ASTM A159, Class 35.

C. Flanged ends, ANSI B16.1, Class 125.

D. Hollow steel ball with vulcanized nitrile rubber covering.

E. 150-psig working pressure.

F. Flygt Corporation Model HDL, Type 2016, 129 Glover Ave., Norwalk, CT 06856, or equal.

2.07 DUAL DISK (DOUBLE DOOR) CHECK VALVE (DDCV)

A. Check valve shall be of the dual disc (door), wafer style with tension spring induced enclosure. Body shall be one-piece construction using cast steel (ASTM A216) or cast iron (ASTM A126, class B). Disc (Door) assembly, spring, and hinge pin shall be type 316.

B. Manufacturers: APCO, Crane Duo-Check II, series 9400, Valmatic series 8800, or equal.

2.08 BALL VALVES (PBV) AND (BV)

A. Plastic Ball Valves (PBV) - sizes 4-inches and smaller: true union design, PVC Type 1, Grade 1, Teflon seats and Viton or EPDM "O" rings, full ports, 150 psi at 73°F water. Valves used for sodium hypochlorite shall be suitable for this service (drilled or modified as needed). Hayward, Chemtrol TU series, Hills-McCanna "McCannaplast", or equal.

B. Bronze Ball Valves (BV) - sizes 2" and smaller: shall have full ports and screwed ends. Bronze body. TFE seats and seals. Type 316 stainless steel trim. Jamesbury; Hills-McCanna "McCannaflo", Worcester, or equal.

C. Three-Way Bronze Diversion Ball Valves (BV) – size 2” and smaller: shall have bronze body, chrome plated ball, reinforced TFE seats and seals with blow-out proof stem design. Apollo series 70-600; Watts B-6780-MI, Worcester, or equal.

2.09 BUTTERFLY VALVES (BFV)

A. Manufacturers: One of the following or equal:

1. DeZurik, Model BAW.

2. Henry Pratt Company, Model 2F11 or XR-70.

B. Valve Body:

1. Material: Cast-iron ASTM A 126 Class B.

Flanges: 125 pound ANSI/ASME B16.1.

2. Body Design

a. Provide short body valves, subject to:

Location in the piping system so that when the valve is operated, its operation will not interfere with, nor be impaired by, adjacent fittings, valves, equipment or other installations.

b. Valves 30 Inches in Nominal Size and Larger: Valve port diameter not reduced more than 1-1/2 inches from the nominal valve diameter.

3. Valve Ends: Compatible with piping system.

C. Disc Materials: Stainless steel or nickel-chrome mating edge on a cast-iron or ductile iron disc.

D. Shaft and Bearings:

1. Type 304 or 316 stainless steel.

2. Thrust Bearings: Self-lubricating, sleeve type. Bearings: Teflon lined with fiberglass backing, or polytetrafluoroethylene with phenolic or stainless steel backing.

E. Disc Pins: Secure valve disc to shaft by means of solid, smooth sided, Type 316 stainless steel or monel, taper or dowel pin. Extend pins through shaft and mechanically secure in place.

F. Seats:

1. For valves less than 24 inches nominal size, bond or vulcanize seats into the valve body.

2. For valves 24 inches nominal size and larger, mechanically retain seats in the valve body.

a. Achieve retaining effect by an epoxy injection method that expands the seat into the body, or by segmented clamping tee lock ring with adjusting screws.

b. Provide means to prevent nuts and screws used to retain rubber seats from loosening due to vibration or cavitation.

c. Seat Retainers: Type 316 stainless Steel

3. Resilient Seat: Withstand 75 pound pull when tested in accordance with ASTM D 429, Method B.

4. Seats retained by a snap ring or other similar device are unacceptable.

5. Seat Materials: Liquid Service: EPDM, Viton.

G. Valve Packing:

1. Valves 4 Inch to 48 Inch in Nominal Size: Self adjusting V-type packing or chevron type packing.

2. Valves 54 Inch in Nominal Size and Larger: Adjustable V-type packing.

H. Butterfly Valve Operators:

1. Manual operators shall be totally enclosed gear type with a suitable indicator arrow to give valve position at any point from full open to fully closed. Electric and hydraulic operators are specified in Sections 15135 and 15136, respectively.

2. Manual Operators for Valves less than 6 Inch Diameter: Hand lever type with a locking device so that the valve can be locked in any position with a wing nut.

   a. Locking Device: Rigid, allowing no vibration or chattering of the valve.

   b. Hand Lever: 12-inches long with a hand grip.

3. Provide underground valves 6 inches in nominal size and larger with a totally enclosed worm gear operator mounted on the valve. Operator shall be suitable for buried service.

   a. Provide an AWWA 2-inch square operating nut with ground level position indication.

   b. Valve Shaft: Extend from the valve to the operator.

   c. Geared Operator: Gasketed for watertightness.

4. Provide limit switches for manual valves where shown on drawings.

5. Manual Operators on Aboveground Butterfly Valves Larger than 6-inches in Nominal Size: Worm geared; valves 10-inches in nominal size and smaller on low pressure air service may be lever operated.

6. Fit butterfly valves located aboveground and not specified to have geared operators with ell or tee wrenches, or handles for operation.

I. Fabrication:

1. Shop coat interior and exterior ferrous metal surfaces of valves and accessories, except as follows:

   a. Finished surfaces.

   b. Bearing surfaces.

c. Stainless steel components.

2. Surface Coatings: All internal and/or external surfaces shall be covered with a polymide cured epoxy coating applied over a sand blasted "new white metal surface" per SSPC-SP10 to a minimum of 12 mils in compliance with AWWA C550.

3. Coating Materials:

<u>High Solids Epoxy</u>:

a. Application: Shop apply to iron and steel surfaces, except stainless steel.

b. Product: As specified in Section 09900.

c. Quality Control: After coating is cured, check coated surface for porosity with a holiday detector set at 1,800 volts, or as specified by coating manufacturer.

1) Repair holidays and other irregularities and retest coating.

2) Repeat procedure until holidays and other irregularities are corrected.

d. Additional field coating, other than touchup coating of damaged surfaces, will not be required.

1) Perform touchup coating within the recoat time recommended by the coating manufacturer.

2) When touchup coating is required after expiration of the recoat time, precede coating by blast cleaning or other surface preparation recommended by the manufacturer of the coating material for satisfactory adhesion between coats.

2.10 BUTTERFLY VALVES (BFV) FOR AIR SERVICE

A. Lugged type, DeZurik Fig. BRS, Keystone Fig. AR1/AR2, Sureseal, or equal.

B. <u>Materials</u>

1. VALVE BODY: Cast iron with exterior liquid epoxy coating to 7 mils.

2. DISC: Aluminum bronze with air profile edge polished to a 60 rms finish for hot air service.

3. SHAFT: 316 stainless steel

4. SEAT: EPDM or equivalent, field replaceable. Seat shall be ½-inch minimum thickness. Valves used on the aeration air service shall be suitable

for 275°F operation.

C. Bearings or bushings shall be self-lubricating and shall be constructed of bronze, acetal, or Teflon, requiring no external lubrication for the life of the valve.

D. Manual operators shall be totally enclosed heavy-duty worm gear type with a suitable indicator arrow to give valve position at any point from full open to fully closed.

2.11 DIAPHRAGM VALVES (DV)

A. Saunder's weir type valve.

B. PVC body, solid Teflon diaphragm, and Viton O-rings.

C. True-union, socket connections, visible position indication.

D. Spears Model 2739, or equal.

2.12 SOLENOID VALVES (SOL V)

A. ¾ inches and smaller.

B. Forged brass body, Buna "N" seals and disc or diaphragm.

C. Orifice diameter equal to or greater than pipe size.

D. Epoxy resin encapsulated, waterproof, high temperature coil, 120 volt, single phase, 60 cycle, explosion-proof enclosure, normally-closed design, continuous duty rated.

E. Jackes-Evans Mfg. Co. Series J; Asco No. 8211, or equal.

2.13 PINCH VALVES (PIV)

A. Valves shall be full cast metal body, mechanical pinch type with flange joint ends on both the body and sleeve trim

B. Materials:

1. Cast Iron Body

2. Pure Gum Rubber Sleeve

C. Valve service shall either be on-off isolation or modulating control. For ESB return modulating control, valve shall be Series 5200E (with 12” x 8” cone sleeve) by Red Valve or equal. For lime slurry feed modulating control, valve shall be Series 5200E (with 1” by ½” by 1” cone) by Red Valve or equal.

2.14 BACKFLOW PREVENTER (RP)

A. Reduced pressure principle.

B. Bronze body construction.

C. Corrosion-resistant internal components.

D. In-line serviceability.

E. Certified under the following Standards:

ASSE No. 1013

AWWA C506

IAPMO Listed

USC FCCC & HR

F. Provide a valve setter and spools as shown on the drawings.

G. Cla-Val RP8N; Febco 880 N, or equal.

H. CONTRACTOR shall provide with every backflow preventer an insulated bag/jacket enclosure with a minimum R-value of 19 to prevent backflow preventer from freezing. Enclosure shall provide for convenient maintenance including Velcro top and bottom and grommets. Additional grommets shall be provided to prevent theft. Insulated bag/jacket shall be double walled vinyl or fiberglass suitable for outdoor use and the intended application. Enclosure shall have a minimum 5-year warranty.

2.15 HYDROSTATIC RELIEF VALVE (PRFV) - (In Concrete Slabs)

A. Hydrostatic pressure relief valves shall be designed to effectively relieve excess ground water from around submerged structures, helping to prevent flotation of the structures.

B. The body of the valve shall be of minimum length with an integral receiver end which will accept a plastic pipe extension. The pipe extension shall be field cut and installed by the Contractor to the desired length. Minimum finished body length shall be equal to the thickness of the floor slab. The strainer is to be removable by rotating manually but shall otherwise remain locked in position. The body shall have an integrally cast water stop to prevent unwanted travel of fluids between the slab and the valve.

C. The cover of the valve shall be of solid cast bronze and shall be machined to seat on a molded neoprene rubber seating ring contained in the top of the body. The cover shall be removable by rotating manually but shall otherwise remain attached to the valve body.

D. Hydrostatic pressure relief valves shall be Waterman Industries, Inc. Model PRF-14E; Clow F-1492, or approved equal.

2.16 HOSE VALVES (HB) or (HV)

A. 1" Hose Valves:

1. Bronze body and trim, composition disc.

2. 1-inch NPT inlet, 1" pipe hose threads outlet, or as shown on Drawings.

3. Cast bronze threaded cap with chain for hose outlet.

4. Nibco no. T-113-HC; Grinnel 3000 HC or equal.

B. 1½ " Angle Hose Valves:

1. Bronze body and trim, composition disc

2. 1½" NPT inlet, 1½" pipe hose threads outlet with 1½" x 1" hose thread reducer, or as shown on the drawings.

3. Cast bronze threaded cap with chain for hose outlet.

4. Nibco Angle Valve; Grinnel 3220 or equal.

2.17 AIR VALVES

A. General: Air valves shall be of the size shown on the drawings with flanged or screwed ends to suit the installation as shown on the drawings. Valves shall be fabricated stainless steel or cast iron body with stainless steel trim. Valves shall be designed for working pressure of 150 psi unless noted otherwise. Valve seals shall be suitable for the pressure range in the pipeline.

B. Sewage Air Valves (SARV): Valves shall meet the general requirements for air valves and shall have long bodies and float stems to minimize clogging. Valves shall be furnished with inlet shut off valve, blow-off valve, flushing water inlet valve, hose, and quick disconnect couplings.

C. Air Release Valve (ARV) and Sewage Air Release Valves (SARV): Valves shall be designed to vent accumulating air while the system is in operation and under pressure.

D. Air and Vacuum Valve (AVV) and Sewage Air and Vacuum Valve (SAVV): Valves shall be designed to pass large quantities of air either out of or into the pipeline during filling or draining operations.

E. Combination Air Valve (CAV) and Sewage Combination Air Valve (SCAV): Valve shall perform both as an air release valve and as an air and vacuum valve as described above.

F. Manufacturer: All air valves used in the project are to be the same in all applications, use APCO, DeZURIK, or equal.

2.18 MUD VALVES

A. Mud valves shall be type 316 stainless steel.

B. Flanged end for anchoring to a flat surface.

C. 2-inch square operating nut and stem extension to the top of all structures, or lever for spring loaded mud valves.

D. Extension stems, pedestal lifts, stem guides, levers and wall brackets will be designed and furnished by the manufacturer of the mud valve to make a complete and operable unit.

E. Manufacturers: Trumbull Manufacturing and Troy Valve, Penn-Troy Manufacturing.

2.19 GLOBE VALVES

A. Design: Valve rated for 200 psi at 150 degrees F. Manual opening valve shall have a handwheel with outside screw and yoke assembly.

B. Materials: Body and bonnet shall be constructed of cast iron, conforming to ASTM A 126 class B. Disc shall be bronze faced.

C. Manufacturers: Crane No. 351, or equal.

2.20 PRESSURE RELIEF, PRESSURE SUSTAINING VALVE

A. Hydraulically operated, pilot controlled, diaphragm valve.

B. Materials:

1. Body: Ductile Iron ASTM A-536

2. Disc: Buna-N Rubber

3. Stem, Nut, and Spring: Stainless Steel

C. Valves shall be ClaVal Model 50-01 or equal.

2.21 TELESCOPING VALVES

A. Manufacturers: One of the following or equal:

1. Troy Valve.

2. Rex Chain Belt.

3. Waterman

B. Design:

1. Valve assembly including the following:

   a. Offset type valve stand.

   b. Operating crank or handwheel.

   c. Rack and pinion or handwheel shaft and lifting stem.

   d. Bearings and bearing guides.

   e. Connecting rods.

   f. Telescoping tube with removable adapter.

   g. Pipe flange.

   h. O-ring seal or ¼-inch neoprene wiper gasket.

2. RISING RACKS: Equip with covers and indicators to show position of telescoping tube. Valves shall be adjustable in ¼-inch nominal increments.

3. TELESCOPING TUBES: Provide a tube style as shown at each location on the Drawings with stem rods adequately fixed to ensure travel in a true, vertical line.

4. Provide stops in the valves to prevent lifting the telescope tube to the base of the valve stand, and design to prevent damage to equipment by forcing the handwheel.

C. Materials:

1. VALVE STAND: Cast-iron or fabricated steel.

2. RACK AND PINION OR HANDWHEEL SHAFT AND STEM: Stainless Steel.

3. TUBE AND ADAPTER: Receiving pipe shall be C900 and slip tube shall be stainless steel.

4. PIPE FLANGE: 316 Stainless Steel.

5. GASKETS: Neoprene

2.22 NEEDLE VALVES (NV)

¾ -inch and Smaller: Crane No. 88 or 89; Stockham B64, or equal.

2.23 PLASTIC AIR RELEASE VALVE (PARV)

A. Design: PVC body with EPDM seals.
Maximum working pressure = 150 psig.

B. Manufacturers: FIP, or equal.

2.24 PLASTIC AIR RELIEF VALVE (PRVP)

A. Design: PVC body, pressure setpoint 5-150 psig angle pattern.

B. Manufacturers: Plast-o-matic Series RVD, or equal.

2.25 WATER PRESSURE REGULATING VALVES

A. Water Pressure Regulating Valves, less than 4-inches

1. Manufacturers:

a. Valves 2 inches and smaller: Watts, Number 223; Masoneilan Number 227; Cla-Val Model 90-01 or equal.

b. Valves 2 inches to 3 -1/2 Inches: Watts/Bailey, Number 30A; Fisher Controls Company, Type 616; Masoneilan Number 525 Cla-Val Model 90-01; or equal.

2. Water Pressure Reducing Valves less than 4 inch size: Direct acting, spring loaded valves except where otherwise specified in the Specifications.

3. Materials

a. Valves 2-inches or smaller: Bronze body, nylon reinforced diaphragm single seat, composition disc.

b. Valves 2-inches to 3-1/2 inches: Double port with stainless steel V-ported or contoured plug, reinforced neoprene diaphragm, and stainless steel stem.

B. Water Pressure Regulating Valves, 4-inches and larger:

1. Manufacturers: Watts Number 115; Cla-Val Model 90-01 series; or equal.

2. Design:

a. Pressure Regulating Valves 4 Inches and Larger: Hydraullically operated, diaphragm actuated, globe patterned valve.

b. Valve: Rated for 125 pounds per square inch gauge.

c. Pilot Line: Equipped with a strainer.

3. Materials:

a. Body and Cover: Cast-iron ASTM A 48 or ASTM A 126.

b. Valve Trim: Bronze.

c. Pilot Control: Cast bronze with Series 303 stainless series trim.

d. Seals: Buna N

2.26 TUBING VALVES

A. Manufacturers: One of the following or equal:

1. Stockham, Figure S-127
2. Jenkins, 1336
3. Crane, 950 TF

B. Valves: 1 piece bar stock ball valve.

C. Materials:

1.	Body:	Type 316 Stainless Steel
2.	Bull:	Type 316 Stainless Steel
3.	Insert:	Type 316 Stainless Stee
4.	Seat:	Reinforced Teflon
5.	Stem Seal:	Reinforced Teflon
6.	Stem:	Type 316 Stainless Steel
7.	Jam Nut:	Steel

2.27 WAFER SWING CHECK VALVES

A. Manufacturers: One of the following or equal:

1. TYCO/ Keystone, Model 815
2. KF Industries, Model 20

B. Valve Design:

1. Semi Lug, swing check design utilizing an external tension spring and weight to assist in faster closure. Valve must be capable of gravity closure should the loss in spring tension occur.
2. Body shall be one-piece construction with field replaceable seals.

C. Materials:

1. Body: Cast Iron, ASTM A-126 Class B

2. Disc: 316 Stainless Steel

3. Seals: Buna-N

4. Bushing: Bronze

5. External Lever: Steel

D. Prior to operation, Wafer Swing Check Valve shall be adjusted by a qualified manufacturer's representative for proper shutoff and smooth operation.

2.28 Foot Valves (FV)

A. Chemical and corrosion resistant PVC construction.

B. PVC body, ASTM F1970, PVC type I.

C. Socket/regular threaded ends.

D. O-ring material shall be Viton.

E. Manufacturers: Spears Manufacturing Company, series 4539-020, or equal.

PART 3: EXECUTION

3.01 All valves and gates shall be installed in the manner and location shown on the plans in strict accordance with manufacturer's recommendations.

3.02 Buried valves with operating nuts shall be provided with covered valve boxes at grade. Where operating nut would otherwise be more than 30-inches below grade, stem extensions shall be provided to bring operating nut 6 to 12 inches below grade.

3.03 Where practical, plug valves shall be installed with shaft horizontal and plug opening upward.

3.04 Hose valves shall be installed in locations shown on the plans. Unless otherwise dimensioned, hose valves set adjacent to structures shall be located three inches from the wall of the structure. Hose valve outlets shall face away from the structures. Hose valves on the potable water system shall have vacuum breakers.

3.05 Buried valves shall be coated with petrolatum wax tape. All buried nuts, bolts, and washers shall be Type 316 stainless steel.

END OF SECTION

SECTION 15790

SPLIT SYSTEM AIR CONDITIONER/HEAT PUMP

PART 1: GENERAL

1.01 DESCRIPTION

A. The work of this section consists of furnishing and installing split system air conditioner at the new Control Building, as shown on the contract drawings and as specified herein.

B. The work shall include, but not necessarily be limited to, the air conditioners, soldering, welding, automatic temperature controls, and all other materials and labor necessary to make complete systems operating to the complete satisfaction of the Engineer.

C. Controls shall be by a local mounted thermostat.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01610: Seismic Anchorage and Bracing

B. Section 01611 : Seismic Design Requirements

D. Division 15: Piping Materials

E. Division 16: Electric Work (except as herein specified)

1.03 PROTECTION OF MATERIALS, WORKS AND GROUNDS

Protect and preserve all materials, supplies and equipment of every description and all work performed. Protect all existing equipment and property of any kind from damage during operations.

1.04 INTERPRETATION OF DRAWINGS

All work shown on the Drawings are intended to be approximately correct and to scale, but figured dimensions and detailed drawings are to be followed in every case. The Drawings shall be taken in a sense as diagrammatic. To carry out the true intent and purpose of the Drawings all necessary parts to make complete approved working systems ready for use shall be furnished. All work shall be installed in professional manner and detailed below.

1.05 CODES, ORDINANCES AND PERMITS

A. All work shall be installed in accordance with the laws, ordinances, rules and regulations of all local and State authorities having jurisdiction, and the rules and regulations of the National Board of Fire Underwriters, and of any public utilities serving the building, whether shown on the Drawings or not. Air conditioners shall be certified by the A.R.I. Standards and be U.L. listed and labeled.

B. Contractor shall obtain all required permits, pay all legal fees for same and in general take complete charge and responsibility for all legal requirements pertaining to this Section of the work.

1.06 COOPERATION WITH OTHER TRADES

A. The work shall be so performed that the progress of the entire building construction including all other trades, shall not be delayed or interfered with. Materials and apparatus shall be installed as soon as conditions of the building will permit and must be installed promptly when and as desired.

B. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other Sections.

C. Any conflicts shall be referred immediately to the Engineer for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Engineer's satisfaction at no expense to the Owner.

D. Where work of this Section will be installed in close proximity to work of other Sections or where there is evidence that the work of this Section will interfere with work of other Sections, assist in working out space conditions to make satisfactory adjustment. Prepare and submit for approval 3/8-inch scale or larger working drawings and sections, clearly showing how this work is to be installed in relation to the work of other Sections. If the work of this Section is installed before coordinating with other trades or so as to cause interference with work of other trades, make changes necessary to correct conditions without extra cost to the Owner.

1.07 WARRANTY

A. A supplier's written warranty shall be provided for the equipment specified in this section. The warranty shall be for a minimum period of five (5) years for start-up or 66 months from time of equipment shipment, whichever comes first. Such warranty shall cover all defects or failures of materials or workmanship which occur as the result of normal operation and service.

1.08 SUBMITTALS

A. In accordance with Section 01300, submit the following:

B. Shop or manufacturer's drawings and technical literature covering details of all equipment, fixtures, accessories and including details for support and bracing of the air handler, condenser and associated piping being furnished under this Section prior to fabrication, assembly, or shipment.

C. Structural calculations and details signed by a California registered civil engineer for support, anchorage or suspension of mechanical HVAC equipment.

C. Manufacturer's installation instructions, parts lists, and operating and maintenance instructions.

PART 2: MATERIALS

2.01 GENERAL

Unit shall have a minimum SEER rating of 14.3. Cooling Capacity shall be 2 tons.

2.02 EVAPORATOR

A. General: Blower coil units shall be completely factory assembled including coil, condensate drain pan, fan, motor, filters and controls in an insulated casing that can be ceiling mounted in horizontal configuration. Units shall be US listed.

B. Casing: Units shall have rugged sheet metal and steel frame construction and shall be painted with an enamel finish. Casing shall be insulated and knockouts shall be provided for electrical power and control wiring.

C. Refrigerant Circuits: The units shall have a single refrigerant circuit. A factory-installed thermal expansion valve shall control refrigerant circuit.

D. Coil: Aluminum fin surface shall be mechanically bonded to 3/8 inch OD copper tubing. Coils shall be factory pressure and leak tested to withstand

E. Fan: Forward curved, dynamically and statically balanced with 3-speed direct drive shall be standard, fan motor bearing shall be permanently lubricated.

F. Controls: Low voltage terminal board, fan contractor, and plug in module for accessory electric heat control shall be included. Provide a 24 volt remote wall thermostat.

H. Filters: Filters shall be included as standard, washable low velocity filters.

I. Manufacturer: Carrier Model 40QAC or equal.

2.03 AIR-COOLED CONDENSING UNITS

A. Provide factory-assembled and tested air-cooled condensing units as indicated, consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls. Provide capacities and electrical characteristics as scheduled.

B. Unit Casings: Design for outdoor installation and provide weather protection for components and controls. Provide removable panels for required access to compressors, controls, condenser fans, motors, and finished with manufacturer's enamel finish.

C. Compressor: Provide reciprocating hermetic-type compressor, designed for air-cooled condensing. Provide compressor lubrications, and crankcase heater. Provide backseating service access valves on suction and discharge ports.

D. Controls: Provide operating and safety controls including high and low pressure cutouts, and anti-recycle timer.

E. Condensing Section: Provide condenser coil of seamless copper tubing mechanically bonded to heavy-duty, configurated aluminum fins. Provide liquid accumulator and sub-cooling circuit and backseating liquid line service access valve. Provide hi-capacity dryer.

F. Condenser Fans and Drives: Provide propeller-type condenser fans for vertical air discharge. Provide permanent-lubricated, ball-bearing condenser fan motors, dynamically and statically balance each fan assembly and provide fan guard.

G Available Manufacturers:Subject to compliance with requirements, manufacturers offering air-cooled condensing units which may be incorporated in the work include, but are not limited to, the following:

H Manufacturer: Carrier Model 38HDR or equal.

2.04 REFRIGERATION SYSTEM REQUIREMENTS

A. Furnish and install all interconnecting refrigeration piping as shown and/or as required. Piping shall be run in accordance with equipment manufacturer's recommendations. Pipe sizes shall be as recommended by equipment manufacturer. Test all refrigeration piping for leaks with an electronic leak detector. Seal and flash all roof and wall penetrations. Provide plastic pipe shields between pipe and hanger. Pitch suction piping down in direction of flow and provide P-trap at bottom of suction riser.

B. Refrigerant Piping: Type L hard copper refrigerant tubing cleaned and capped with wrought copper solder joint fittings and couplings. All joints shall be brazed.

C. All stop valves shall be Henry, or approved equal, bronze diaphragm, packless type, solder ends. Sight glass shall be Henry Dri-Vue or approved equal.

D. Refrigerant suction piping shall be insulated with ¾-inch thick Armstrong Armaflex foamed plastic pipe insulation. Fittings and valves shall be covered with segmented sections on the pipe insulation installed in accordance with manufacturer's published instructions. All joints between sections of insulation shall be sealed with Armstrong No. 520 adhesive. The exterior of all exposed insulation shall be given two brush coats of Armstrong "Finish."

2.05 POWER SUPPLY

A. Unit shall be provided to accept a 3-phase 480 voltage supply.

2.06 ACCESSORIES

A. Factory matched remote thermostat and controls for the air conditioner with a temperature control range of 40°F to 90°F. Manual summer/winter switch.

B. Provide grilles and ceiling brackets furnished by manufacturer.

PART 3: EXECUTION

3.01 INSTALLATION

A. Install air conditioner units as indicated on the contract drawings and in accordance with the manufacturer's installation instructions.

B. Hang units from building substrate. Mount at height maintaining greatest headroom possible unless otherwise indicated. Support units with brackets supplied by unit air conditioner manufacturer.

3.02 EQUIPMENT CHECK, TEST AND START

A. The check, test and start of the system shall be performed by the contractor. This contractor shall provide all personnel, test instruments, and equipment to properly perform check, tests and start, at no additional cost to the owner.

B. The check, test and start of each piece of equipment shall be in accordance with manufacturer's printed instructions. Two (2) copies of the completed check, test, and start report of each piece of equipment shall be bound with the operation and maintenance manuals.

END OF SECTION

SECTION 16050
GENERAL ELECTRICAL WORK

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated by respective specification.

C. Work included:

1. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.

1.02 RELATED WORK

A. Section 01010 General Construction Information and Requirements

B. Section 01300 Submittals

C. Section 01680 Facility Operation and Maintenance Manuals

D. Division 16 Electrical Specifications

1. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with the WORK of equipment Specifications, the WORK of instrumentation Sections.

2. Concrete, excavation, backfill, and steel reinforcement required for encasement, installation, or construction of the WORK of the various Sections of Division 16 is included as a part of the WORK under the respective Sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.

E. Division 17 Instrumentation Specifications

1.03 REGULATORY AGENCIES AND STANDARDS

A. Regulatory Agencies: Installation, materials, equipment and workmanship shall conform to the latest provisions of the following agencies:

1. CBC	California Building Code
2. CCR (TITLE 24 – PART 3)	California Electrical Code
3. NEC (NFPA 70)	National Electrical Code: 2023 Edition
4. OSHA	Occupational Safety and Health Act
5. Title 8, Subchapter 5,	California Administrative Code Electrical Safety Orders
6. UBC	Uniform Building Code

B. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

C. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 CFR 1926, as applicable), state building standards, and applicable local codes and regulations.

D. Standards: Where referenced in these specifications or on the drawings, the publications and standards of the following organizations apply:

1. AEIC	Association of Edison Illuminating Companies
2. ANSI	American National Standards Institute
3. ASTM	American Society of Testing and Materials

4. ICEA	Insulated Cable Engineers Association
5. IEEE	Institute of Electrical and Electronics Engineers
6. NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
7. NFPA	National Fire Protection Association
8. NETA	International Electrical Testing Association

E. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

1.04 SUBMITTALS

A. General

1. Furnish submittals in accordance with the requirements of Section 01300 – Submittals.
2. Custom-prepared Shop Drawings.
    a. The CONTRACTOR shall provide custom-prepared shop drawings with terminal numbers, wiring labels, component data, and all associated electrical components required by the CONTRACT DOCUMENTS.
        - Manufacturer supplied shop drawings shall be rejected without review IF NOT customized to meet CONTRACTO DOCUMENTS.
3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.
4. Cross out options not proposed or delete from the Shop Drawings.

B. Shop Drawings

1. Shop drawings shall include the following:
    a. Complete material lists stating manufacturer and brand name of each item or class of material.
    b. Shop Drawings for grounding WORK not specifically indicated
    c. Front, side, rear elevations, and top views with dimensional data
    d. Location of conduit entrances and access plates
    e. Component data
    f. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers
    g. Method of anchoring, seismic requirements, weight
    h. Types of materials and finish
    i. Nameplates
    j. Temperature limitations, as applicable
    k. Voltage requirement, phase, and current, as applicable
    l. Front and rear access requirements
    m. Test reports
    n. Grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.
2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.
2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Include with each submittal a copy of this specification section, with addenda updates included, and all referenced and applicable sections included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The ENGINEER shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

1.05 FACILITY OPERATION AND MAINTENANCE MANUALS

A. General

1. Submit complete operation and maintenance manual in accordance with the requirements of Section 01680 – Facility Operation and Maintenance Manuals.
2. Submit complete operation and maintenance manual for equipment in accordance with the following:
   a. Operating instructions and start-up procedures including receiving and installation requirements.
   b. Maintenance instructions listing preventive and corrective maintenance procedures. Corrective maintenance procedures shall identify the most probable failures and the appropriate repairs. Test measurement levels shall be referenced to specific test points on the installed equipment.
   c. Spare parts data shall be furnished for each item of material and equipment specified. The equipment data shall include the following:
      - A list and itemized price breakdown of spare parts recommended for stocking shall be furnished.
      - The parts selected shall be those which, in the manufacturer's judgment, will be involved in the majority of maintenance difficulties encountered.
   d. Control schematics, ladder diagrams and interconnection drawings.
   e. Catalog cuts and technical manuals for all components of the system. Provide original technical manuals as published by the manufacturers. Photocopies will not be acceptable.
   f. Copy of all guarantees and warranties issued for the various items of equipment, showing all dates of expiration.
   g. Copies of all factory and field test results.
   h. Final copies of all shop and submittal drawings, incorporating manufacturing and field changes. Where drawings are larger than 11 by 17 inches, provide the full-size drawings neatly folded and installed in 8.5 by 11-inch top loading clear plastic sheet protectors. In addition, provide copies of these drawings reduced to 11 by 17-inch sheet size.
   i. Where AutoCAD electronic files are required per other sections, provide CD-ROM with electronic files of all drawings.

j. All irrelevant information on equipment and materials which are in the O&M manuals shall be crossed out with a bold black marker.

1.06 As-Built Drawings

1. Prepare as-built drawings, including but not limited to showing invert and top elevations and routing of duct banks and exact location of concealed below-grade electrical installations, and color coding of each individual control conductor.
2. Maintain AS-BUILT drawings and update in conjunction with CONTRUCTION progress of installation. AS-BUILT drawings shall be a full-sized set of drawings marked to reflect deviations, modifications and changes.
3. Furnish the drawings to the ENGINEER in accordance with the requirements of Section 01300 – Submittals.

1.07 IDENTIFICATION FOR ELECTRICAL SYSTEMS

A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

C. Warning Signs

1. 600 Volts Nominal, or Less
   a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.
2. Greater than 600 Volts
   a. Buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at greater than 600 volts nominal shall be lockable.
   b. Provide permanent and conspicuous warning signs reading as follows: DANGER – HIGH VOLTAGE – KEEP OUT.
3. Mark indoor electrical installations that are open to unqualified persons and contain metal-enclosed switchgear, unit substations, transformers, and other similar associated equipment over 600 volts nominal, with appropriate caution signs.
4. Outside Branch Circuits and Feeders over 600 Volts
   a. Post warning signs in plain view where unauthorized persons might come in contact with live parts: WARNING – HIGH VOLTAGE – KEEP OUT.

D. Isolating Switches

1. Provide isolating switches not interlocked with an approved circuit-interrupting device with a sign warning against opening them under load.

1.08 PERMANENT PUBLIC UTILITIES REQUIREMENTS

A. Contact the serving utility and verify compliance with requirements before construction.

B. Coordinate schedules for WORK by utilities.

1. The CONTRACTOR to coordinate and schedule pre-construction utility coordination meeting with utility service representative with thirty (30) days of CONTRACT.

C. Where conduits and conductors in the WORK are indicated to be larger, heavier schedule, or have greater protective coating than utility requirements, provide the larger size, heavier schedule, or greater protection.

D. Provide electrical service as indicated and as required by the serving utility.

E. Verify and provide service conduits, fittings, transformer pad, grounding devices, and service wires not provided by the serving utility.

F. Verify with the utility the exact location of each service point and type of service, and pay charges levied by the serving utilities as part of the WORK.

1.09 PERMITS AND INSPECTION

A. Obtain permits and pay inspection fees according to the General Conditions.

1.10 AREA DESIGNATIONS

A. General

1. Designations for raceway system enclosures shall comply with the requirements of Section 16110 – Electrical Raceway Systems.
2. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections unless indicated otherwise.
3. Designations for other electrical WORK not included in the above Paragraphs shall be as follows:

AREA	NEMA ENCLOSURE CLASSIFICATION					
	1	3R	4X	7	12	Notes
Recycled Water Pump Station – Outdoor		X				
Recycled Water Pump Station – Indoor			X			
Maintenance Building – Outdoor		X				
Maintenance Building					X	
Drainage PS		X				

4. Designations for electrical WORK not included in the above Paragraphs shall be NEMA 4X.
5. Installations in hazardous locations shall conform strictly to the requirements of the indicated Class, Group, and Division.

B. Material Requirements

1. Provide sealing fittings in chlorine and hydrofluosilicic (HFS) acid areas.
2. Construct NEMA 4X enclosures of Type 304 or 316 stainless steel, except in chlorine and HFS areas where non-metallic enclosures shall be provided.
3. Do not coat NEMA 4X enclosures.
4. Construct NEMA 7 enclosures of cast aluminum where used with aluminum conduit, and of cast iron when used with galvanized steel conduit.
5. Do not coat NEMA 7 and 9 enclosures.
6. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

1.11 TESTS

A. The CONTRACTOR shall be responsible for factory and field tests indicated in Division 26, as required by the ENGINEER, and as required by other authorities having jurisdiction.

B. Furnish necessary testing equipment.

C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.

D. Reporting

1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.
3. Submit field test reports for review prior to Substantial Completion.

E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.

F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.

1.12 CONSTRUCTION SEQUENCING

A. Existing Utilities

1. Exercise extreme caution when digging trenches to not damage existing underground utilities.
2. The cost of repairs of damages caused during construction shall be included as a part of the WORK.

B. Field Verifications

1. Visit the Site before submitting a Bid to become better acquainted with the WORK of this Contract.
2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.
3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.
4. The CONTRACTOR shall be responsible for field verifying the available space in substation switchboards to integrate new power circuit breakers.
5. The cost for the above verifications shall be included as part of the WORK.

PART 2 - MATERIALS

2.01 GENERAL

A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.

B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.

C. Furnish equipment and material products of the same manufacturer. Equipment and materials shall be of industrial grade standard of construction.

D. Temperature Ratings of Equipment Terminations

1. Provide terminations and lugs rated for use with 75-degree C conductors.
2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.
3. Provide equipment and materials suitable for storage, installation and operation in an ambient of 0°C to 50°C up to an elevation of 3,300 feet above sea level, except where more stringent conditions are stated in individual equipment specifications.

E. Furnish factory finished electrical equipment, wireways and panels with manufacturer's standard primer and enamel topcoats, unless stated otherwise in the individual equipment specifications.

1. Provide 1 pint of the equipment manufacturer's touch-up paint per 500 square feet of painted surface for repair of damaged enamel topcoats.

2.02 ELECTRICAL IDENTIFICATION

A. Nameplates

1. Fabricate nameplates from white-letter, black-face laminated plastic engraving stock, such as **Formica Type ES-1** or equal.
2. Securely fasten each nameplate, using fasteners constructed of brass, cadmium-plated steel, or stainless steel, and screwed into inserts or tapped holes as required.
3. Provide engraved characters of the block style, with no characters smaller than 1/8-inch top to bottom.
4. Provide nameplates for field mounted devices and instruments, such as pressure switches, limit switches, flow meters, etc. Identify the name of the device and its unique identifier:

Examples:	Pressure Switch	Limit Switch
	PS-1	LS-1

5. Where it is impractical to attach laminated nameplates to field devices, provide 19-gauge, 2-inch square brass tags with 1/4-inch black filled engraving. Provide Seton Standard Brass Valve tags or equivalent. Attach tags with No. 16 brass jack chain.

B. Conductor and Equipment Identification

1. Provide imprinted plastic-coated cloth marking devices, such as manufactured by Brady, Thomas & Betts, or equal.
2. Alternatively, provide heat-shrunk plastic tubing, imprinted split-sleeve markers cemented in place.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide materials and provisions required for a complete and operable system, even if not required explicitly by the Contract Documents.

B. Typical provisions include terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

C. The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and shall be used as closely as possible.

D. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.

E. Conduits

1. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.
2. Provide exposed or encased routings as indicated, except conceal conduit in finished areas unless indicated otherwise.
3. Size conduits encased in a slab for conduit OD not to exceed 1/3 of the slab thickness, and lay out and space as to not impede concrete flow.

F. Placement

1. Install conduit and equipment as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.

2. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.
3. Where exact locations are not indicated, such locations will be determined by the ENGINEER.
4. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.
5. Adjust luminaire locations in order to avoid obstructions and to minimize shadows.

G. Circuits
1. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
2. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).
3. Where circuits are combined in the same raceway, de-rate conductor ampacities in accordance with NEC requirements.

H. Workmanship
1. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the WORK.
2. Coordinate installation in the field with other trades in order to avoid interferences.

I. Protection of Equipment and Materials
1. Fully protect materials and equipment against damage from any cause.
2. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.
3. Keep moving parts clean and dry.
4. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

J. Provide incoming utility power equipment in conformance with the utility's requirements.

K. Provide starters shall be in accordance with the requirements of Section 16480 – Low Voltage Motor Control Center for starters in MCC'S, and with Section 16485 – Industrial Control Panels for starters not in MCC'S.

3.02 CORE DRILLING

A. Perform core drilling as required for the installation of raceways through concrete walls and floors.

B. Base the locations of floor penetrations, as may be required, on field conditions.

C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.

D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities.

E. Repair damage to encased conduits, wiring, and piping as part of the WORK.

3.03 CONCRETE HOUSEKEEPING PADS

A. Provide concrete housekeeping pads for indoor floor-standing electrical equipment.

B. Extend housekeeping pads for equipment, including future units, 3-1/2 inches above the surrounding finished floor or grade, and 2-inches larger in both dimensions than the equipment, unless otherwise indicated.

C. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.

D. Extend housekeeping curbs to 3 inches above the finished floor or grade.

3.04 EQUIPMENT IDENTIFICATION

A. Provide nameplates for panelboards, control and instrumentation panels, starters, switches, and pushbutton stations.

B. In addition to nameplates, equip control devices with standard collar-type legend plates.

C. Identify control devices within enclosures as indicated and similar to the subparagraph above.

D. Provide suitable inscribed finish plates for toggle switches that control loads out of sight of switches and for multi-switch locations of more than 2 switches.

E. Use equipment names and tag numbers, where indicated, on nameplates.

F. Provide typewritten circuit directories for panelboards, that accurately reflect the outlets connected to each circuit.

G. Terminal Blocks

1. Label termination points on terminal blocks by identifiers on the blocks.
2. Provide identifiers that have been preprinted by the terminal manufacturer or custom-printed.
3. Hand-lettered markers will not be accepted.

H. Provide arc-flash labels for all distribution equipment, stand-alone disconnects, starters, and VFDs. Fill in all values as required by NFPA 70E, and as calculated as part of the Protective Device Study. Verify that all settings as prescribed by the approved Protective Device Study have been implemented in the field.

3.05 CLEANING

A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.

B. Remove temporary tags, markings, stickers, and the like.

C. Remove oil and grease spots with a non-flammable cleaning solvent by carefully wiping and scraping cracks and corners.

D. Apply touch-up paint to scratches on panels and cabinets.

E. Vacuum clean electrical cabinets and enclosures. Do not use compressed air to clean cabinets.

F. Clean luminaires inside and out. Replace failed lamps.

G. Properly dispose cleaning debris and refuse off-site.

END OF SECTION

SECTION 16070
SEISMIC RESTRAINTS AND SUPPORTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide seismic restraint devices for electrical systems, complete and operable, in accordance with the Contract Documents.

1.02 SUBMITTALS

A. Submittals shall be in accordance with Section 16050 – General Electrical Work.

B. Submit seismic anchoring calculations with equipment and raceway submittals. Calculations and determination of anchor types shall be performed and stamped by a licensed structural engineer registered in the State of California. Engineer shall either be employed by the equipment manufacturer or the equipment manufacturer shall hire an independent consultant to perform these services.

C. Submit equipment anchoring methods. Include anchoring locations, anchor types and minimum anchor embedment depths.

D. Submit catalog cuts and material list for each anchor type.

E. Submit recommended torque values for bolting.

PART 2 - MATERIALS

2.01 SEISMIC ANCHORING AND RESTRAINTS

A. Equipment Anchors:

1. Securely anchor electrical equipment. Anchoring shall have the capability of withstanding seismic forces per ASCE 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 13, with SDS = 0.686, IP = 1.5, RP = 2.5, and ap = 1.0.

B. Raceway Supports:

1. Seismically support raceways (conduit, cable tray, busway, etc.) 2.5 inches inside diameter and larger and suspended 12 inches or more from the top of the raceway to the bottom of the support for the hanger. Raceway supports shall have the capability of withstanding seismic forces per ASCE 7-05, Minimum Design Loads for Buildings and Other Structures, Chapter 13, with SDS = 0.686, IP = 1.5, RP = 2.5, and ap = 1.0.

2. Seismically supported raceway systems shall currently be pre-approved by the California Office of Statewide Health Planning and Development.

2.02 MOUNTING HARDWARE

A. Miscellaneous Hardware

1. Provide nuts, bolts, and washers constructed of stainless steel.

a. Materials

- All Areas: Anchor bolts and screws shall be Type 316 ASTM A276 stainless steel. Nuts shall be hex Type 316 stainless steel, ASTM A194, Grade 8M, or ASTM F594, Type 316 stainless steel.

2. Provide threaded rods for trapeze supports constructed from continuous threaded galvanized steel, 3/8-inch diameter minimum.

a. Materials

- All Areas: ASTM A276, Type 304 stainless steel.

B. Struts

1. Construct struts for mounting of conduits and equipment of 304 stainless steel.

2. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
3. Aluminum strut for free-standing support frames are not permitted.
4. Strut Manufacturer, or Equal: **Unistrut**; **B-Line**

C. End Caps
1. Provide plastic protective end caps for all exposed strut ends.
2. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

D. Anchors
1. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.
2. Wood plugs will not be accepted.
3. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Star**.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The CONTRACTOR shall provide and install equipment anchors and raceway supports in accordance with the final shop drawings and manufacturer's recommendations. Properly torque all bolts to the recommended values.

END OF SECTION

SECTION 16110
ELECTRICAL RACEWAY SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

1.02 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 – Submittals, and Section 16050 – General Electrical Work.

B. Shop Drawings

1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.

2. As-Built Drawings

a. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

b. Furnish the drawings to the ENGINEER in accordance with the requirements of Section 01300 – Submittals.

PART 2 - PRODUCTS

2.01 GENERAL

A. Pull and junction boxes, fittings, and other indicated enclosures that are dedicated to the raceway system shall comply with the requirements of this Section.

2.02 CONDUIT

A. Rigid Galvanized Steel (RGS) Conduit

1. Provide rigid steel conduit manufactured from mild steel, hot-dip galvanized inside and out.

2. Provide rigid steel conduit manufactured in accordance with NEMA C80.1 – Electrical Rigid Steel Conduit, and UL-6 – Electrical Rigid Metal Conduit - Steel.

3. Manufacturer, or Equal

a. **Allied Tube & Conduit**

b. **Wheatland Tube**

B. PVC Rigid Non-Metallic Conduit

1. Provide rigid non-metallic conduit manufactured from Schedule 40 PVC, as indicated, and sunlight-resistant.

2. Provide rigid non-metallic conduit manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit.

3. Manufacturer, or Equal

a. **Carlon**

b. **Cantex**

C. Rigid PVC-Coated Galvanized Steel (PVC-GRS) Conduit

1. The conduit shall meet the requirements for GRS conduit as indicated above.
2. Bond a PVC coating to the outer surface of the galvanized conduit.
3. Ensure that the bond between the coating and the conduit surface is greater than the tensile strength of the coating.
4. Provide the inside surfaces and threads of the conduit with a 2-mil urethane coating.
5. Provide a PVC coating thickness not less than 40 mils.
6. The PVC-coated GRS shall be manufactured in accordance with the following standards:
    a. UL-6
    b. ANSI C80.1
    c. NEMA RN1 - PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
7. Manufacturer, or Equal
    a. **Robroy Industries**
    b. **O'Kote**
    c. **Thomas & Betts**

D. Liquid-Tight Flexible Conduit

1. Provide liquid-tight flexible conduit constructed of a flexible galvanized metal core with a sunlight-resistant thermoplastic outer jacket.
2. Provide liquid-tight flexible conduit manufactured in accordance with the requirements of UL-360 - Steel Conduits, Liquid-Tight Flexible.
3. Manufacturer, or Equal
    a. **Anaconda, Sealtite**
    b. **Electriflex, Liquatite**

E. Electrical Metallic Tubing (EMT) or Intermediate conduit (IMC) will not be accepted.

2.03 FITTINGS AND BOXES

A. General

1. For use with metallic conduit, provide cast and malleable iron fittings of the threaded type with 5 full threads.
2. Fittings and Boxes
    a. Provide fittings and boxes with neoprene gaskets and non-magnetic stainless steel screws.
    b. Attach covers by means of holes tapped into the body of the fitting.
    c. Covers for fittings attached by means of clips or clamps will not be accepted.
    d. Provide surface-mounted switches and receptacles shall be housed in FD-type weatherproof conduit fittings. Bell type are not permitted.
3. Provide boxes larger than standard cast or malleable types manufactured of Type 304 or Type 316 stainless steel, NEMA 4X.
4. Terminations
    a. In outdoor areas, terminate conduit in rain-tight hubs.
    b. Manufacturer, or Equal
        - **Myers**
        - **O.Z. Gedney**

- **Appleton**

c. In other than outdoor areas, provide sealed locknuts and bushings.

B. Malleable Iron Fittings and Boxes

1. For use with galvanized steel conduit, provide fittings and boxes constructed of malleable iron or gray-iron alloy with zinc plating.
2. Manufacturer, or Equal
   a. **Crouse-Hinds (EATON) Form 5**
   b. Equivalent by **O.Z. Gedney**
   c. Equivalent by **Appleton**

C. PVC Fittings and Boxes

1. For use with rigid non-metallic conduit, provide fittings manufactured of solvent-welded PVC.
2. Provide boxes manufactured of PVC or fiberglass reinforced polyester (FRP).
3. Manufacturer, or Equal
   a. **Hoffman**
   b. **Crouse-Hinds (EATON)**
4. Provide welding solvent as required for the installation of non-metallic conduit and fittings.

D. PVC-Coated GRS Fittings

1. For use with PVC-coated GRS, provide PVC-coated coated that are the products of the same manufacturer as the conduit.
2. Provide male and female threads and internal surfaces with a 2-mil urethane coating.

E. Stainless Steel Boxes

1. Provide stainless steel boxes with PVC-coated GRS conduit and where indicated.
2. Provide NEMA 4X stainless steel boxes, constructed of Type 316 stainless steel.
3. Provide stainless steel of a minimum of 14-gauge thickness, with a brushed finish.
4. Door Hinges
   a. Provide doors with full-length stainless steel piano hinges.
   b. Non-hinged boxes will not be accepted.
5. Manufacturer, or Equal
   a. **Hoffman**
   b. **Rittal**

F. Sheet Steel Boxes

1. Sheet steel boxes shall be galvanized steel outlet and switch boxes.
2. Manufacturer, or Equal
   a. **Raco**
   b. **Steel City**
   c. **Appleton Electric**

2.04 WIREWAY

A. General

1. Provide wireway of the lay-in type and NEMA-rated for the area in which it is to be installed in accordance with the requirements of Section 16050 – General Electrical Work.

2. Separate power, control, signal and communications cables by grounded metallic dividers in wireways or run in separate wireways.

B. Fittings and Covers

1. Provide fittings and sections with non-magnetic stainless steel screws.
2. Attach covers by hinges and clamps to the bodies.
3. Covers attached by means of clips or screws will not be accepted.
4. Provide covers and bodies constructed of aluminum or minimum 14-gauge steel.

C. Grounding

1. Ground the steel and aluminum wireway bodies.
2. Provide steel dividers with steel wireways or aluminum dividers with aluminum wireways, and ground by means of an individual grounding conductor.
3. Non-metallic dividers will not be accepted.

D. Terminations

1. In indoor and outdoor areas, terminate conduit in rain-tight hubs as manufactured by Myers, O.Z. Gedney, or equal.
2. Manufacturer, or Equal
   a. **Myers**
   b. **O.Z. Gedney**

PART 3 - EXECUTION

3.01 GENERAL

A. Run wiring in raceway unless indicated otherwise.

B. Install raceways between equipment as indicated.

C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.

D. Bends and Offsets

1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.
2. Provide factory elbows wherever possible.

E. Routing

1. Where raceway routings are indicated, follow those routings to the extent possible.
2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.
3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.
4. Adjust routings in order to avoid obstructions.

F. Coordination

1. Coordinate between trades prior to installing the raceways.
2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.

G. Support rod attachment for ceiling-hung trapeze and cable tray installations shall meet the seismic requirements in the area where the Project is located.

H. Install exposed raceways parallel or perpendicular to structural beams.

I. Expansion Fittings

1. Install expansion fittings with external bonding jumpers wherever exposed raceways cross building expansion joints.
2. Install expansion/deflection fittings where conduit movement is expected in more than one dimension, and where conduits transition out of structures in locations where differential settlement may occur.
3. Encased Expansion Fittings
    a. Install encased expansion fittings wherever encased conduits cross building expansion joints.
    b. Deflection type fittings shall not be required for encased conduits crossing an expansion joint within a single structure.
4. Provide expansion and expansion/deflection fittings constructed of the same material as the raceway to which they are installed.

J. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.

K. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.

L. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

3.02 CONDUIT

A. Provide exposed conduit manufactured of rigid galvanized steel, except as follows and unless indicated otherwise:

1. In areas with chlorine or hydrofluosilicic acid, provide Schedule 40 PVC conduit.
2. In areas containing lime or ferric chloride, provide PVC-coated GRS conduit.
3. For conduit containing only grounding system bonding conductors, provide Schedule 80 PVC conduit.

B. Power conduit encased in concrete shall be constructed of Schedule 40 PVC.

C. Analog control or instrumentation conduit shall be Schedule 40 PVC.

D. Concrete Encasement

1. Where PVC or GRS conduit is stubbed up from a concrete encasement, provide a PVC-coated GRS elbow.
2. The conduit shall emerge from the concrete in a direction perpendicular to the surface whenever possible.
3. Do not encase conduit in the bottom floor slab below grade.

E. Size

1. Provide exposed conduit of 3/4-inch minimum trade size.
2. Provide encased conduit of one-inch minimum trade size.

F. Install supports at distances required by the NEC.

G. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.

H. Penetrations

1. Provide conduit passing through walls or floors with plastic sleeves.
2. Perform core drilling in accordance with the requirements of Section 26 00 00 – Electrical Work, General.
3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

I. Conduits embedded within a slab, wall, or beam (other than those merely passing through) shall meet the following requirements:
   1. Conduits with their fittings embedded within a column shall not displace greater than 4 percent of the gross area of cross section;
   2. Conduits shall not be larger in outside dimension than 1/3 the overall thickness of the slab, wall, or beam in which it is embedded; and,
   3. Conduits shall not be spaced closer than 3 outside diameters on centers.

J. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.

K. Coat threads with a conductive lubricant before assembly.

L. Joints
   1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.
   2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.
   3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.
   4. Replace conduit with wrench marks.
   5. Where installed in chemical or fuel containment areas, the conduit shall not have joints or fittings located below the top of the containment area to prevent entry of chemicals or fuel into the conduit system.

M. Slope
   1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.
   2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.
   3. Take extreme care in order to avoid pockets or depressions in the conduit.

N. Where conduits from duct banks enter building walls below grade, transition to PVC-coated RGS at least 12” outside the wall. Installation of PVC-coated rigid steel conduit though a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.

O. Connections
   1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.
   2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.
   3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.

P. Provide conduit seal fittings in hazardous classified locations, in strict accordance with the NEC.

Q. Provide conduit, fittings, and boxes required in hazardous classified areas that are suitably rated for the area, and provide in strict accordance with NEC requirements.

R. Duct sealant shall be foam duct sealant such as **Polywater FST or approved equal.** Provide duct sealant at the following locations:

1. Where required by NEC Article 300.7.
2. In areas where chlorine gas or fumes from sodium hypochlorite exist to prevent passage of gas through the raceway system.

S. Empty Conduits

1. Tag empty conduits at both ends to indicate the final destination.
2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.
3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.
4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

T. Identification of Conduits

1. Identify conduits at ends and at pulling points.
2. Identification shall be the unique conduit number assigned in the Contract Documents.
3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.
5. Provide conduit identification by a stamped or engraved non-corroding metal tag attached to the conduit bushing.
6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – Electrical Work, General, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.
7. Markings with a pen or paint will not be accepted.

U. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.
2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.
3. Provide box identification by a stamped or engraved non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 16050 – General Electrical Work, and attached to the box or enclosure.
4. Markings with a pen or paint will not be accepted.

V. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

END OF SECTION

SECTION 16111
UNDERGROUND RACEWAY SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide underground raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. Pullboxes, and fittings that are dedicated to the underground raceway system shall comply with the requirements of this Section.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals, and Section 16050 – General Electrical Work.

B. Shop Drawings

1. Submit complete catalog cuts of all raceways, fittings, pullboxes, marked where applicable in order to show proposed materials and finishes.

C. As-Built Drawings

1. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.
2. Show routings, burial depths, and handhole locations and sizes, and where applicable, connections to drainage systems.
3. Furnish the drawings to the ENGINEER in accordance with the requirements of Section 01300 – Submittals.

PART 2 - PRODUCTS

2.01 PULLBOXES

1. Provide traffic-type covers with an H-20 loading, except as otherwise indicated.
    a. H-20 loading rating as defined by AASHTO for fully loaded 20-ton truck.
2. Identify pullbox covers as "ELECTRIC", “LIGHTING”, or “COMM” by providing raised letters cast into the covers as required.
    a. Power and Signal distribution pull boxes shall be identified with “PPB-XX” OR “SPB-XX”, where XX is the identification number noted on the plans.
3. Provide frost-proof and water-tight grey iron frames and covers with solid lids and inner lids, and with 28-inch clear openings.
4. Bolt the covers and lids to cast-in-place steel frames using corrosion-resistant hardware.
5. Factory-prime the frames.
6. Provide covers constructed of cast-iron, and provide pick holes.
7. Provide frames with a 1/2-inch drilled and tapped hole and lug in order to accommodate a No. 4/0 AWG bare stranded copper conductor connected to a ground rod and the ground conductor of power cables passing through the pullboxes.
8. Provide Hinged Spring-assistant covers for all pull boxes 24” X 36” internal dimensions and above.
    a. All other pull boxes shall be non-hinged type bolted covers.

B. Equip pullboxes with pulling-in irons, opposite and below each ductway entrance.

C. Provide 12” pull box extensions when noted on the contract drawings.

D. Provide pullboxes with closed bottoms; open-bottom pullboxes will not be accepted.

E. Provide PVC ductbank conduits with end bells.

F. Brackets

1. Provide non-metallic, non-conductive brackets and stanchions in pullboxes as required for racking wiring through the pullboxes. Attach to pullboxes walls using stainless steel anchors and hardware.

2. Brackets and stanchions: **Underground Devices, Inc.,** or equal.

G. Precast Pullboxes Manufacturer, or Equal

1. **Jensen Precast**

2. **Old Castle**

3. **U.S. Precast**

2.02 DUCTBANKS

A. Provide underground ducts constructed of Schedule 40 PVC.

B. Encase ducts in red-dyed concrete with steel reinforcing bars.

C. Provide concrete with a 3,000-psi compressive strength conforming to the requirements of Section 03100 – Cast-in-Place Concrete.

D. Colorant

1. The concrete shall be dyed red throughout the ducts; surface treatment will not be accepted.

2. Provide colorant consisting of an integral red-oxide coloring pigment in the proportion of 8 pounds per cubic yard of concrete.

3. The costs, if any, of cleaning coloring pigment from the concrete delivery equipment and other related cleanings shall be considered as part of the WORK.

E. Grounding

1. Ductbanks shall contain a No. 4/0 bare stranded copper ground wire.

2. The ground wire shall be continuous through the ductbank and terminate at power distribution equipment and the grounding grid.

F. Identification Tape

1. Provide continuous lengths of underground warning tapes located 12 inches above and parallel to the ductbanks.

2. Provide tape consisting of 6-inch wide polyethylene film, imprinted with "CAUTION - ELECTRIC UTILITIES BELOW."

3. Provide tape that contains a non-ferrous metal foil conductor sandwiched in the tape for detection purposes.

4. Manufacturer, or Equal

a. **Brady**

2.03 UNDERGROUND CONDUIT ACCESSORIES

A. Duct Spacers/Supports:

1. Provide high density polyethylene or high impact polystyrene.

2. Interlocking web or mesh design.

3. Provide 3-inch minimum spacing between conduits.

4. Accessories, as required:

a. Hold down bars.

b. Ductbank strapping.

PART 3 - EXECUTION

3.01 GENERAL

A. Install underground raceways between pullboxes as indicated.

B. Raceway systems shall be electrically and mechanically complete before conductors are installed.

C. Provide bends and offsets that are smooth and symmetrical, and fabricated with tools designed for this purpose.

D. Use factory elbows wherever possible.

E. To the extent possible, follow the raceway routings as indicated on the Drawings.

F. Adjust the indicated routings as necessary in order to avoid obstructions.

G. Coordination with Other Trades

1. Coordinate with other trades prior to installation of raceways.
2. The lack of coordination shall not be justification for extra compensation.
3. Perform removal and re-installation to resolve conflicts as part of the WORK.

3.02 DUCTBANKS

A. Install ductbanks in accordance with the following criteria:

1. Assemble the duct using high-impact, non-metallic spacers and saddles in order to provide conduits with vertical and horizontal separation.
2. Set the plastic spacers every 5 feet.
3. Anchor the duct array every 5 feet in order to prevent movement during the placement of concrete.
4. Lay the duct on a grade line of at least 3 inches per 100 feet, sloping towards pullboxes.
5. Install the duct and adjust the pullbox depths such that the top of the concrete envelope is a minimum of 18 inches below grade and a minimum of 24 inches below roadways.
6. Accomplish changes in direction of the duct envelope by more than 10 degrees horizontally or vertically by using bends with a minimum radius 24 times the duct diameter.
7. Stagger duct couplings a minimum of 6 inches.
8. Provide select backfill or sand for the bottom of the trench.
9. Cleaning
    a. Clean each bore of the completed ductbank by drawing through it a standard flexible mandrel, one foot long and 1/4 inch smaller than the nominal size of the duct.
    b. After passing the mandrel, draw through a wire brush and swab.
10. For spare raceways that are not indicated to contain conductors, provide a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway.

B. Grout duct entrances smooth, and terminate ducts with flush end bells.

C. Assemble sections of pre-fabricated pullboxes using waterproof mastic, and set on a 6-inch bed of gravel as recommended by the manufacturer or as required by field conditions.

D. Provide watertight ductbank penetrations through walls of pullboxes, and building walls below grade.

E. Terminate concrete-encased ductbanks at building foundations.

F. Where ducts enter buildings, provide duct sealant in every duct at the building-end of the duct run to prevent water or condensation entry from the duct bank into the building.

1. Manufacturer, or Equal

a. **Polywater FST, FST-MINI**

G. When duct enters the building on a concrete slab on grade, do not encase the duct but transition to rigid steel PVC-coated conduits on stub-ups.

H. Sealing

1. Where an underground conduit enters a structure through a concrete roof or a membrane-waterproofed wall or floor, provide a sealing device.
2. Manufacturer, or Equal
   a. **Link-Seal**
3. Use the sealing device with rigid steel conduit.
4. Transition from PVC to rigid steel conduit prior to building entry.

END OF SECTION

SECTION 16120
WIRE AND CABLING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

B. In the event that motors provided are larger horsepower than the motors indicated, raceways, conductors, starters, overload elements, and branch circuit protectors shall be revised as necessary to control and protect the increased motor horsepower in accordance with Section 16460 – Electric Motors. Revisions are part of the WORK of this Section.

1.02 SUBMITTALS

A. The CONTRACTOR shall submit Shop Drawings in accordance with Sections 01300 – Submittals and 16050 – General Electrical Works.

B. Submit catalog cuts and material list for each conductor type. Indicate insulation material, conductor material, voltage rating, manufacturer and other data pertinent to the specific cable, such as type shielding, number of pairs and applicable standards.

C. Submit cable test results in accordance with this Section as well as Section 16950 – Electrical Tests.

1.03 DELIVERY, STORAGE AND HANDLING

A. The CONTRACTOR shall protect all cables from damage at all times.

B. Cable ends shall be protected from water entry in accordance with the manufacturer's recommended procedures. Cable ends shall not be left open in manholes or other locations subject to submergence. If the cable ends become submerged prior to splicing or termination, the cables shall be replaced in their entirety.

C. Cables shall be pulled into raceways in accordance with the manufacturer's requirements. Under no circumstances shall cable pulling tensions exceed the manufacturer's written instructions.

D. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

PART 2 - MATERIALS

2.01 GENERAL – LOW-VOLTAGE CABLE

A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor and/or solid conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

2.02 LOW-VOLTAGE POWER AND LIGHTING CONDUCTORS

A. Wire rated for 600 volts in duct or conduit for power and lighting circuits shall be single conductor, Class B Type XHHW-2 cross-linked polyethylene conforming to UL-44 - UL Standard for Thermoset-Insulated Wires and Cables.

1. THHN/THWN wire shall not be permitted to be used for any power or control wiring in this project, except as specifically permitted within control panels per Section 17200 – Control Panels.

B. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

C. Wiring for 600-volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

2.03 LOW-VOLTAGE CONTOL CONDUCTORS

A. Low voltage control wire in duct or conduit shall be the same type as power and lighting wire indicated above.

B. Control wiring shall be No.14 AWG, Class B Type XHHW-2 cross-linked polyethylene conforming to UL-44 - UL Standard for Thermoset-Insulated Wires and Cables

C. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable,** or equal.

D. Multi-Conductor Cable: Where multi-conductor cable is indicated on the drawings, provide type TC, multi-conductor cable assemblies with an overall heat, moisture, and sunlight resistant PVC jacket. Conductor insulation shall be color coded per ICEA-S-58-679, method 1, colored compounds with tracers.

2.04 ETHERNET NETWORK 10/100/1000 BASE-T/TX Cable

A. Ethernet Network 10/100/1000 BASE-T/TX Cable:

1. Provide Ethernet network cables of the cable types indicated on the Drawings and as specified. If no type is indicated, provide Category 6 STP.
2. Conductors:
    a. Solid copper conductors.
    b. Minimum No. 24 AWG.
3. Insulation:
    a. Polyolefin polyethylene (non-plenum) or FEP (plenum).
    b. 600 V rated insulation.
    c. 100% shieded
4. Color code:
    a. Pair 1: White/blue stripe and blue.
    b. Pair 2: White/orange stripe and orange.
    c. Pair 3: White/green stripe and green.
    d. Pair 4: White/brown stripe and brown.
5. Outer jacket:
    a. Sunlight resistant, flame-retardant polyvinyl chloride outer jacket.
    b. White sheath for Voice.
    c. Blue sheath for Data.
    d. Low Smoke, CMP-50, FEP, clear jacket where required by fire code.

B. STP Cable Hardware

1. Cat6 EZ-RJ45 connectors.

2.05 INSTRUMENT CABLE

A. Instrumentation cable shall be rated at 600 volts TC, minimum.

B. Individual conductors shall be No. 16 AWG stranded, tinned copper. The insulation shall be color coded polyethylene: black-clear for 2 conductor cable and black-red-clear for 3 conductor cable.

C. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 16 or larger AWG stranded, tinned copper drain wire, and a PVC outer jacket with a thickness of 0.047-inches.

2.06 VARIABLE FREQUENCY DRIVE CABLE

A. VFD power cable shall be three (3) conductor, stranded copper, PVC jacketed, shielded type, tray cable (TC) rated 1000/2000 volts with three (3) symmetrical ground conductors. The individual conductors shall be UL listed as Type XHHW-2 rated for 90 degrees C at wet and dry locations, with XLPE insulation.

B. VFD Cables shall be manufactured by **Belden, Southwire**, **OLFLEX,** or equal.

2.07 CABLE SPLICES AND TERMINATIONS

A. Where cable lugs are required for power cable terminations, utilize compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Pressure type, twist-on connectors (wire nuts) will not be acceptable.

B. Pre-insulated fork tongue lugs shall be **Thomas & Betts, Burndy**, or equal.

C. General purpose insulating tape shall be **Scotch No. 33**, **Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M,** or equal.

D. Labels for coding 600-volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.

E. Stress cone material for make-up of medium voltage shielded cable shall be as manufactured by **Raychem, 3M**, or equal.

F. Shielded power cable shall be spliced using kits specifically designed to splice medium voltage, shielded power cables. Splice kits shall be designed for continuous submergence. Heat shrink splice kits shall be **Raychem "Type HVS"**, or equal. "Cold" shrink splice kits shall be **3M "5760 Series",** or equal. The CONTRACTOR's personnel shall be trained by the splice kit manufacturer for proper installation of the splices, and shall submit certification of training as a shop drawing. A certified trainee shall perform the splice work.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

B. The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares for future use.

C. Conductors shall not be pulled into any raceway until raceway has been cleared of moisture and debris.

D. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.

E. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be neatly fanned out to terminals.

3.02 FIELD ASSEMBLY

A. General

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.

2. In general, there shall be no cable splices in underground manholes or pullboxes. If splices are necessary, the cables shall be spliced using submersible cable splices, suitable for continuous submergence. Splices in underground manholes and pullboxes may be made only with the approval of the ENGINEER.

3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.

4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

B. Control Wire and Cable

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.

2. In motor control centers and control panels, control wire and spare wire shall be terminated to terminal strips.

3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Instrumentation Wire and Cable

1. Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4 - 20 mA system.

2. Two and 3 conductor shielded cables installed in conduit runs which exceed available standard cable lengths may be spliced in pullboxes with the prior approval of the ENGINEER. Such cable runs should have only one splice per conductor.

D. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR. Cables rated above 2,000 volts shall be spliced or terminated only at equipment terminals indicated.

2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape over-taped with a minimum of 2 layers of high temperature tape.

3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as a Shop Drawing.

4. VFD shielded power cables shall have the shield grounded at all locations where it is exposed.

3.03 IDENTIFICATION

A. Cable Identification

1. Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

2. Identification Numbers

a. The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on "as built" drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

b. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.

c. Color Coding of Power Wire: Provide color coding throughout the entire network of feeders and circuits (600 volts and below) as follows:

Phase	240/120 Volts	208/120 Volts	240 Volts	480/277 Volts
Phase A	Black	Black	Black	Brown
Phase B	Red	Red	Red	Orange
Phase C	---	Blue	Blue	Yellow
Neutral	White	White	White	Gray
Ground	Green	Green	Green	Green

d. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs.

e. Color coding tape shall be used where colored insulation is not available. Colored identification tape may be used on conductors between the local disconnect and the load, where permitted by the NEC. Any phase changes necessary for proper rotation shall be made at the driven equipment where colored insulation is used. Phase changes may be made on the load side of the local disconnect, where phase colors are identified using tape.

f. Control wires shall have colored insulation. Field control wires shall be violet, with the exception of neutral.

g. Conductors #10 AWG and smaller shall have factory color coding with solid color insulation.

h. Conductors #8 AWG and larger shall have factory color coding with solid color insulation or with three wide color stripes co-extruded with the cross-linked polyethylene insulation or shall have black insulation with on-site application of colored tape at conductor terminations and at splices. If color tape is used, install 2 layers minimum.

i. General purpose AC control cable shall be red. General purpose DC control cable shall be blue.

j. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.

k. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

3.04 FIELD QUALITY CONTROL

A. Cable Assembly and Testing: Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

B. Factory test results shall be submitted in accordance with Section 03100 – Submittals, prior to shipment of cable. The following field tests (in addition to the tests specified in Section 16950 – Electrical Tests) shall be the minimum requirements:

1. Insulation resistance testing, using a DC megohmmeter, shall be performed on cables operating at more than 2,000 volts to ground. Time-resistance readings shall be taken and recorded at intervals of 30 seconds and one minute. Time-resistance voltage levels shall be per the cable manufacturer's recommendations.
2. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
3. Field testing shall be done after cable is installed in the raceways.
4. Field tests shall be performed by a NETA-certified test organization. Test results shall be submitted to the ENGINEER for review and acceptance.
5. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.

C. Continuity Test: Control and instrumentation cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

END OF SECTION

SECTION 16125SM

FIBER OPTIC GENERAL REQUIREMENTS (SINGLE-MODE)

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section apply to all Sections in Division 16, except as otherwise indicated by respective specification.

C. Work included:

1. The WORK of this Section includes the minimum requirements for product quality and performance, including preparation and installation of fiber optic cabling.
2. Electrical Contractor (Contractor) shall furnish and install the fiber optic system and equipment as shown on the Contract Drawings and specified in these specifications.
3. All general provisions of the Contract Documents apply to all work specified in the Division 16 and 17 specifications.
4. Furnish all necessary labor, materials, equipment, and incidentals required to install a complete fiber optic system in accordance with these specifications and the accompanying drawings, whether they are itemized or not.
5. Provide submittals including all required drawings, product catalog cuts and specifications, bill of materials, and operation and maintenance manuals for all equipment, instruments and systems specified in the Division 16 and 17 specifications.
6. The general extent of the fiber optic work includes furnishing and installing the following items:
   a. Single-mode optical fiber cabling in existing conduits and innerduct.
   b. Fiber optic connectors and termination cabinets.
   c. Splices as indicated and required.
   d. Field Testing including OTDR testing of all fibers and startup services.
   e. Training as required.
   f. 25 Year warranty.
7. All fiber optic equipment and materials, including installation and testing, shall conform to the applicable Codes and Standards listed in these Specification sections. All fiber optic work shall conform to the latest version of the National Electric Code (NEC). Nothing on the Drawings or in the Specifications shall be construed as the permission to perform any work that is not in conformance with these Codes and Standards.
8. Provide protection for all materials and equipment against loss or damage in accordance with provisions described elsewhere in these Contract Documents. Throughout this Contract, follow manufacturer's recommendations for storage. Protect equipment from the effects of weather. Store items in clean, dry, indoor locations. Store items that are subject to corrosion under damp conditions and items containing fiber optic insulation, such as transformers, conductors, motors, and controls in clean, dry, indoor, heated locations.
9. Provide post installation protection for materials and equipment from physical damage and corrosion. Cap conduit runs during construction to prevent entrance of foreign subjects in conduits.

1.02 RELATED WORK

A. Division 16 Electrical Specifications

1.03 APPLICABLE CODES AND STANDARDS

A. All fiber optic, instrumentation and control equipment and materials, including installation and testing, shall conform to the following Codes and Standards, where applicable:

1. ANSI/TIA/EIA-568-B and B.3, Commercial Building Telecommunications Cabling Standards
2. ISO/IEC 11801, Generic Cabling for Customer Premises
3. IEEE 802.3, Ethernet, Fast Ethernet, Gigabit Ethernet, 10 Gigabit Ethernet
4. ITU-T G.652.D
5. ATM Forum, User Network Interface (UNI)
6. ANSI X3T9.5, FDDI
7. EIA/TIA 492CAAB and ITU G.652.C
8. EIA-455-41, Crush Resistance Standards
9. EIA-455-25, Impact Resistance Standards
10. EIA-455-104, Flexure Standards
11. EIA/TIA 492CAAB, Detailed specification for Class Iva Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
12. EIA/TIA-598, Color Coding of Fiber Optic Cables
13. ITU G.652.C, Characteristics of a single-mode optical fiber cable
14. NFPA - National Fire Protection Agency
15. OSHA - Occupational Safety and Health Act Standards
16. UL - Underwriters Laboratories, Inc.

B. The revisions of these Codes and Standards in effect on the date of issuance of the Contract Documents shall apply. Codes and Standards referenced shall be considered minimum acceptable work. In instances where two or more Codes are at variance, the most restrictive requirements shall apply.

1.04 SUBMITTALS

A. Submit shop drawings in accordance with Section 16050.

B. All shop drawings shall be submitted on 11 x 17-inch or 24 x 36-inch sheets at one time. Drawings prepared on 8 1/2 x 11-inch sheets will not be accepted. Shop drawings shall be drawn to scale or completely dimensioned and shall include all information required to completely describe the contents. Drawings shall show front views, plan views, elementary wiring diagrams and numbered connection points.

C. Product Submittals:

1. Product submittals shall be submitted within 20 workdays after the Notice to Proceed. Any products that are purchased, fabricated or shipped before the product submittals have been favorably reviewed by the Engineer shall be done solely at the Contractor's risk.
2. Furnish to the Engineer detailed specifications of the material, shop drawings including product dimensions, catalog cuts, fiber optic diagrams, wiring diagrams, bill of material, and other descriptive material as required to fully describe the equipment being furnished under these Specifications Sections.

D. Fiber Optic Routing Diagram:

1. The Fiber Optic Routing Diagram show all connections, splices and fiber optic devices. All cables shall be numbered consecutively on the diagrams. Cable identification shall be unique. "Typical" diagrams are not acceptable.

2. The Fiber Optic Routing Diagram shall show the connections and physical relationship of fiber optic devices and apparatus in pairs or groups by functionality or use within each location. Identify each fiber by its size and color on the Fiber Optic Routing Diagrams according to the fiber numbers shown on the Fiber Optic Routing Diagrams. Fiber identification on adapter plates shall be as shown on the Fiber Optic Routing Diagrams.

E. Cable Pulling Calculations:

1. Submit Pulling Calculations including distance, lubrication amounts, maximum and expected pulling tensions per segment(s). Pulling Calculations shall be submitted and approved prior to cable installations.

2. The Contractor may perform calculations on the worst case or typical segment(s) as an overall guideline. These may be submitted in place of each segment if desired.

3. Submit a Pulling Plan that describes how the fiber optic cables will be installed. This plan shall include sequence of installation steps, such as those described in Part 3, order of installation and quantity of cables, including cable name and cable number. The approved plan is required prior to cable installation.

4. Interduct cleaning and proofing may occur in advance of this plan's approval.

F. Fiber Optic Link Loss Calculations: Submit Fiber Optic Link Loss Calculations as described in Part 3.3.C prior to fiber link testing.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance (O&M) Manual: Submit an O&M Manual for all fiber optic equipment. Include as-built product information in the O&M manual. Prepare O&M Manuals in compliance with the requirements of other Specification sections and include the following:

1. All approved shop drawings pertinent to facility operation and maintenance.

2. Equipment calibration data and calibration sheets including equipment/instrument description.

3. As-built drawings containing complete wiring diagrams.

B. Test results/reports: Place test results/reports under each respective equipment item tested.

C. Product Data: Submit catalog data for each cable type and for each fitting and accessory.

D. Provide manufacturer's warranty certificates for all devices and equipment supplied.

1.06 QUALITY ASSURANCE

A. General:

1. Maintain one copy of each document on site.

2. The revisions of these Codes and Standards in effect on the date of issuance of the Contract Documents shall apply. Codes and Standards referenced shall be considered minimum acceptable work. In instances where two or more Codes are at variance, the most restrictive requirements shall apply.

3. Nothing on the Contract Drawings or in the Specifications shall be construed as the permit for work or materials that do not conform to the preceding Codes and Standards. All work shall also be performed in accordance with the Owner's Standards and local Utility Codes. Variances and discrepancies between the preceding Codes and Standards, the Design Standards provided by the Owner, and local Utility Standards shall be submitted to the Engineer for resolution and approval prior to implementing such variances and discrepancies.

4. The fiber optic installation shall be in complete compliance with the Codes and Standards as specified. If Code violations are noted during the inspection of the installation, the Contractor shall furnish, without extra charge, any additional material and labor which may be required

to provide compliance with the Codes and Standards, even though the work is not explicitly mentioned in the Specifications or shown on the Contract Drawings.

5. Apply and pay for all permits required by any of the legally constituted public authorities for the installation or construction of the work included in this Division.
6. Arrange and pay for any inspections or examinations required and deliver certificates of all such inspections to the Engineer.
7. When these specifications call for materials or construction of a better quality or larger sizes than those required by the above-mentioned Standards, Rules and Regulations, the provisions of the Specifications shall take precedence.

B. Schedule: Submit a construction schedule for review and approval by the Owner/Engineer prior to beginning of the construction. The schedule shall include the order for the fiber optic work including submittals, excavation, manufacturing dates, delivery dates, installation, testing, startup, and commissioning.

C. Coordination: Coordinate the fiber optic work with Owner, Engineer, other trades, utilities, and code authorities for a rapid completion of the project. If any cooperative work must be altered due to lack of proper supervision of such, or failure to make proper provisions, then the Contractor shall bear the expense of such changes as necessary to be made in the work of others.

D. Project Meetings: Attend all scheduled project progress meetings including installation, start-up and commissioning.

E. Supervision and Workmanship: Supervise the work and ensure that the project is being carried on with best possible workmanship and within the construction schedule. The Contractor shall employ a competent foreman to oversee the work throughout the entire period of construction, if the Contractor is not able to provide supervision.

F. Inspections: All work or materials covered by the Contract Documents shall be subject to inspection at any and all times by the Engineer. If any material does not conform to the Contract Documents, or does not have an "approved" or "approved as noted" submittal status; then the Contractor shall, within three (3) days after being notified by the Engineer, remove the unacceptable material from the premises. If said material has been installed, the entire expense of removing and replacing same, including any cutting and patching that may be necessary, shall be the Contractor's responsibility.

G. Temporary Power: Temporary electrical power required for construction of the project is the sole responsibility of the Contractor. Use of temporary power shall be in strict compliance with the pertinent Codes and Standards. Upon completion of the project, the Contractor shall remove the temporary power equipment, material, and wiring from the project site as property of the Contractor.

H. Project Documentation:

1. Prepare as-built Drawings as the work progresses. Mark any modifications made to the installation and shop drawings with Red Pen and keep one set of such drawings at the job site for inspection by the Engineer at any and all times. All marks shall be clear and legible. Submit all the as-built drawings to the Engineer within two weeks of project acceptance by the Owner/Engineer.
2. Operating and Maintenance manuals including instructions and maintenance on each type of equipment shall be furnished.

1.07 FIBER OPTIC CONTRACTOR QUALIFICATIONS

A. The Contractor shall be solely responsible for management and installation of the fiber optic and instrumentation systems required for this project.

B. The Contractor shall meet the following minimum qualifications:

1. Work experience on similar or greater complexity of at least five previous fiber optic projects under one company name and under the present company name.
2. Possession of valid California C-10 Electrical Contractor's License.
3. Regular engagements in similar fiber optic installations for the municipal water and wastewater industries or other off-premises installations.

1.08 INTERPRETATION OF CONTRACT DRAWINGS

A. The Contract Drawings are diagrammatic and do not show the precise locations and orientations of conduits, equipment and instrumentation. The Contractor shall use best possible construction practices, with coordination with Owner and Engineer to determine locations and orientations of conduits, equipment, and instrumentation. Generally, the Contract Drawings shall be followed as closely as existing conditions and work of others permit. All unapproved deviations from the Drawings required to make the work conform to existing structures and to the work of others, shall be made at the Contractor's expense.

B. Any errors or omissions of details in the Contract Drawings and Specifications shall not relieve the Contractor from correctly installing all materials necessary for a complete and operational fiber optic system.

C. The Contractor is advised to inspect the project site and verify all measurements and conditions prior to bidding the project. The Contractor shall be responsible for correctly installing the project whether or not there are discrepancies between the actual field conditions and Contract Drawings. No extra compensation will be allowed for unresolved differences that may have surfaced during the bidding period and work shown on the Contract Drawings.

1.09 AS-BUILT RECORD DRAWINGS

A. Prepare as-built drawings as the work progresses. Mark any modifications made to the installation and shop drawings with Red Pen and keep one set of such drawings at the job site for inspection by the Engineer at any and all times. All marks shall be clear and legible. Submit all the as-built drawings to the Engineer within two weeks of project acceptance by the Owner/Engineer.

B. Prepare as-built drawings in compliance with the requirements of Section 16050 General Electrical Work. Include fiber optic work revisions and actual routes of exposed, embedded and buried conduits, which may differ from the Shop Drawings.

C. A working copy of as-built drawings shall be maintained on project site at all times during construction.

1.10 SPARE PARTS

A. Supply all spare parts prior to final payment. All spare parts shall be sealed in plastic bags and delivered to the Owner in a heavy-duty plastic storage box.

B. Connectors: Provide 10 connector kits of each size and type used.

C. Patch cords: Provide (5) 1-meter and (5) 2-meter single-mode SC-SC patch cords.

1.11 WARRANTY

A. Leave the fiber optic in proper working condition. The Contractor shall replace any work including material furnished by him that develops defects within 25 years from the date of final acceptance at no cost to the Owner.

B. Complete fiber optic installation shall carry a manufacturer’s warranty of not less than 25 years, as offered by Corning Fiber or equal.

C. The Contractor shall have a qualified staff of experienced personnel available to provide service on a 2-workday notice during the warranty period. Such personnel shall be capable of fully testing and diagnosing the hardware and software installed and correcting the defects.

D. In the event that the Contractor fails to respond on a 2-workday notice or fails to correct the problems, the Owner, at its discretion, will have the warranty work completed by others. The total cost for the work performed by others shall be reimbursed in full by the Contractor. The use of others, shall not change the warranty terms or relieve the Contractor or supplier from fulfilling the remainder of the warranty requirements.

E. Prior to "final acceptance", the Contractor shall furnish to the Engineer a list of warranty information for all manufacturers products used on the project. The list shall include the following:

1. Manufacturer's contact information including name, service contact person, phone number, and address.
2. Material and equipment description including part number, equipment number, serial number, and model number.
3. Completed test forms.
4. Manufacturer’s warranty expiration date.

PART 2 - MATERIALS

2.01 QUALITY

A. All products specified in these Specifications and shown on the Contract Drawings are intended to be of the highest quality. All equipment and materials shall be new and the products shall be from reputable suppliers with adequate experience in the manufacturing of these products. For uniformity, provide only one manufacturer for each type of product. Provide the manufacturer's latest product that conforms to these Specifications.

B. All equipment shall be designed for the service intended. The equipment shall be rugged and have ample strength to withstand all stresses that may occur during fabrication, transportation, erection, and continuous or intermittent operation.

C. All individual parts making up the product shall be adequately braced, anchored, and installed in a neat and workmanlike manner. All components and devices installed shall be standard items of industrial grade, unless otherwise noted in the Contract Documents, and shall be of sturdy and durable construction. Light duty, fragile, and competitive grade devices of doubtful durability shall not be used. Utility, as well as appearance and safety, shall be given consideration in the design of products.

D. All products shall be Underwriters Laboratories (UL) listed, unless this requirement is waived by the Engineer or specified otherwise.

E. Products that are specified in these Specifications establish a standard of quality and do not prohibit the use of equal products of other manufacturers. However, all products furnished, whether specified or not, shall be favorably reviewed by the Engineer prior to purchase, delivery and installation.

F. When required by the Specifications or requested by the Engineer, the Contractor shall submit equipment or material samples for test or evaluation. The samples shall be furnished with information as to their source and prepared in such quantities and sizes as may be required for proper examination and testing, with all freight and charges prepaid by the Contractor. All samples shall be submitted before shipment of the equipment or material to the job site and in ample time to permit the making of proper tests, analyses, examinations, rejections, and resubmissions before incorporation into the work.

G. All fiber optic materials shall be new and free from defects. All fiber optic materials shall conform, where applicable, to the Standards listed in this Section, unless otherwise noted.

2.02 NAMEPLATES

A. All fiber optic equipment and devices including all pull boxes shall be properly identified with a descriptive nameplate.

B. Pull Boxes and Vaults:

1. Label all pull boxes. Additionally, all pull boxes with splices shall have a second nameplate attached next to the first that shall read FIBER SPLICE WITHIN.
2. Provide stainless steel nameplates with machine engraved or stamped letters. Size of letters shall be 1/2-inch high, minimum. Letters shall be machine engraved. All nameplates shall be screw mounted with stainless pan head machine screws tapped into the front of the pull box collar. Adhesive material shall not be used.

2.03 SINGLE-MODE FIBER OPTIC CABLE

A. Manufacturers:

1. Corning Altos All-Dielectric cable.
2. Approved equal.

B. Description: Single-mode outdoor rated, single-mode, dual window (1300 nanometers and 1500 nanometers), dielectric, single jacketed, water blocking yarn (or gel filled) fiber optic cable.

C. General Fiber Specifications:

1. The fiber optic cable described below shall be a dielectric, single jacketed, water blocking yarn or gel filled, with loose tube construction optimally protected from water infiltration. The cable shall contain single-mode, dual window (1300 nanometers and 1500 nanometers) fibers and shall meet or exceed the specifications listed below.
2. All optical fibers must be usable and meet specifications.
3. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi.
4. The attenuation specification shall be a maximum value for each cabled fiber at 23 +5 OC.

D. Single-Mode Cable Specifications:

1. The fiber cable shall be single-mode with a low-water cable that meets or exceeds EIA/TIA 492CAAB and ITU G.652.D.
2. The cable shall meet all requirements stated in the ANSI/ICEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-1999.
3. The cable shall be an all-dielectric single jacket cable.
4. The cable shall have a glass-reinforced plastic (GRP) dielectric central member, loose tube and a single MDPE jacket. The jacket material shall have a low coefficient of friction that is sufficiently low enough to allow free movement of the fibers.
5. The fiber cable shall contain 6 or 12 fibers as indicated on the drawings.
6. Individual fibers shall be color coded per EIA/TIA-598 standards.
7. The cable shall contain a buffer tube filling that is either a water-blocking yarn or homogenous hydrocarbon-based gel with anti-oxidant additives to prevent water intrusion and migration. If gel filled, the gel chemical shall be chemically and mechanically compatible with all cable components, non-nutritive to fungus, non-hygroscopic and electrically non-conductive. The filling shall be clean, free of dirt and foreign matter and shall be readily removable with conventional non-toxic solvents.
8. The cable shall have manufacturer rating of at least 600 pounds maximum tensile strength loading during installation (loading).
9. The cable shall have manufacturer rating of at least 130 pounds maximum tensile strength for unloaded application (in-service).

E. Fiber Characteristics:

1. Each optical fiber shall consist of a germania-doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

2. Single-mode fibers within the finished cable shall meet the following requirements:
    a. Core Diameter 8.3 µm (nominal)
    b. Cladding Diameter 124 µm + 2.0 µm
    c. Core to Cladding Offset 1.0 µm
    d. Coating Diameter 250 µm + 15 µm
    e. Cladding Non-circularity 2.0 %
    f. Proof/Tensile 100 kpsi, minimum
    g. Attenuation:
        - @ 1310nm < 0.4 dB/km
        - @ 1550nm < 0.4 dB/km
    h. Attenuation at the Water Peak < 2 dB/km
    i. Chromatic Dispersion:
        - Zero Dispersion Wavelength 1301.5 to 1321.5nm
        - Zero Dispersion Slope 0.092 ps/(nm2 •km)
    j. Maximum Dispersion 3.3 ps/(nm•km) for 1285 to 1330 nm < 18 ps/(nm•km) for 1550 nm
    k. Cut-Off Wavelength < 1250 nm
    l. Mode Field Diameter 9.3+0.5µm at 1300 nm
    m. Macrobending Loss measured at 1500nm on loose tube fiber of 100 turns of 75mm diameter (tested in accordance with EIA-455-62), shall be less or equal to:
        - 0.1 dB @ 1310 nm
        - 0.5 dB @ 1550 nm
3. Label cables according to the plans and special specifications at the time of installation. Label cable at each end, at each pull box or junction box along the run. Cable label lettering shall be at least 0.25 inches in height and be black lettering with a white sleeve.

F. Shipping:
1. Cables shall be shipped on a strongly constructed reel. The reel shall be designed to prevent damage to the cable during both shipment and cable installation.
2. Both cable ends shall be sealed to prevent moisture from entering or gel filling compound from escaping.
3. The outer cable shall be wrapped in protective wrap over the outer turns of the cable.
4. Both fiber optic cable ends shall be equipped with flexible pulling eyes.
5. Factory Testing shall be favorably completed and submitted to the Engineer prior to installing the fiber optic cable.
6. OTDR Testing of each cable shall accompany each reel.

G. Testing: Factory Testing requirements are covered in Part 3.3 of this specification and covers both factory and field tests.

2.04 SINGLE-MODE SC CONNECTORS

A. Manufacturers:
1. Corning 95-200-41 (Unicam).
2. Corning 95-201-41-SP (Anaerobic-Cure).
3. Approved equal.

B. Fiber Optic connectors shall be a ceramic ferrule LC type for single-mode fiber. The connectors shall use an Anaerobic or Unicam connection to the fiber strands.

C. The connector shall comply with the following standards:

1. ANSI/TIA/EIA-568-B.3
2. TIA/EIA 604-2

D. The connectors shall comply to the following characteristics:

1. Type: SC
2. Application: Single-mode
3. Connector: 2.5 mm Zirconia Ceramic
4. Installation: Factory or Field by factory certified technicians
5. Operating Temperature Range: 40 oF to +167 oF
6. Installed Attenuation: 0.2 dB (typical), 0.75 dB (max)
7. Repeatability: 0.5 dB (max)
8. Return Reflection: < -55 dB
9. Pull out strength: > 50 pounds
10. Body color: Blue
11. Bayonet: Polymer

2.05 FIBER OPTIC PATCH PANELS

A. Enclosure:

1. Manufacturer:
   a. Corning ICH-06P for Wall Mounting (Interior Building Locations)
   b. Corning WIC-02P for Remote Panel Mounting (Interior Control Panels Locations)
   c. Approved equal.
2. The enclosure shall be installed and fully loaded with six 6-port (SC-SC) adapter plates.
3. The enclosure shall have top and bottom grommets as well as swing-out doors and latches.
4. The enclosure shall have strain-relief hardware and routing guides to help maintain minimum bend radius.

B. At locations shown on the plans, provide a fiber optic patch panel that shall have a connection port per fiber strand. If future requirements are stated, this capability shall be provided within this contract.

C. The patch panels shall be constructed of 16-gauge powder coated steel. The patch panel shall be modular and shall be capable of housing up to 12 SC fibers, either three 4-fiber cables or two 6-fiber cables.

D. Adapter Plates:

1. Manufacturers:
   a. Corning
2. Adapter plates shall have 12 SC single-mode female to female connection points.
3. Provide space for up to four adapter plates.

2.06 SPLICES – FUSION

A. The field splices shall connect to fiber cables together for the purpose of a permanent splice in the cables.

B. If these splices are necessary to support the pulling plan of the fibers, these splices and enclosures shall be provided and installed at no additional cost to the Owner.

C. Typical field splice loss shall be <0.05 dB for single-mode fibers. The maximum installed loss may not exceed 0.30 dB (per TIA-568) for any splice.

D. The splice enclosure shall meet the following requirements:

1. Manufacturer:
    a. Corning with (6) splice trays.
    b. Approved equal.
2. The cable splice enclosure shall be a complete kit including the following:
    a. Connection brackets.
    b. Stand-off studs with locking nuts.
    c. Ground clamps.
    d. Outer shell (typically 2 halves).
    e. Inner shell assembled in 2 parts.
    f. End caps as required.
    g. Inner shell supports for splice trays shall be provided.
    h. Outer shell clamp assemblies.
    i. Cable entry through the ends of the enclosure.
    j. Insulation/sealing tape.
3. The splices shall be encased in an outdoor rated splice enclosure at a mutually agreed pull box location or as specified on the plans. All changes shall be marked on the field set of drawings at the time of construction.
4. The splice enclosure shall be air and water tight, corrosion resistant, rodent-proof and re-enterable.
5. The splice enclosure shall be manufacturer certified for below ground, junction (pull box) installation.
6. The splice case shall be no larger than 5.5 inches in diameter by 22.5 inches in length (nominal). The splice case shall be designed and equipped with the necessary mounting hardware to be attached to the side of the pull box, and to be suspended vertically with sufficient clearance at each end for acceptable cable bends.

E. All fusion splices shall be made with a fusion splicer. The unit shall be portable and capable of both AC and battery powered operation. The unit shall be capable of splicing the cable specified and supplied under this contract. The fusion splicer shall have the following characteristics:

1. Splice protection sleeve heater.
2. Battery charging unit.
3. Spare electrodes, fuses and lamps.
4. Power meter/ light source and carrying case(s).

F. Splice construction shall be per splice and cable manufacturer’s guidelines. A copy of the procedure shall be submitted and approved prior to performance of fusion splicing.

G. Mechanical Splices are not permitted.

H. The accepted procedure shall be on site and with the fusion installer at the time of the splice. The Engineer shall be informed of when splicing operations will take place and may witness the splicing

operations. Failure to strictly adhere to these specifications will result in the Contractor having to re-splice the connection at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 GENERAL

A. All work in this Section shall conform to the Codes and Standards outlined herein.

B. Employ personnel that are skilled and experienced in the installation and connection of all elements, equipment, devices, instruments, accessories, and assemblies. All installation labor shall be performed by qualified personnel who have had experience on similar projects. Provide experienced workmanship for all installations.

C. All work shall be performed in a workmanlike manner by craftsmen skilled in the particular trade. Work shall be performed in accordance with the Plans, Specifications, manufacturers' recommendations, and the best practice of the trade. Completed work shall present a neat and finished appearance.

D. The Contractor shall be responsible for, and shall correct by repair or replacement, at his sole expense, equipment that in the opinion of the Engineer, is malfunctioning caused by faulty mechanical or electrical assembly by the Contractor. Necessary tests to demonstrate that the electrical and mechanical operation of the equipment is satisfactory and meets the requirements of these Specifications shall be made by the Contractor at no additional cost to the Owner.

E. Ensure that all equipment and materials fit properly in the installations and locations for which they are intended. Perform any required work to correct improper installations at no additional expense to the Owner.

F. The Engineer reserves the right to halt any work that is found to be substandard or being installed by unqualified personnel.

G. All cutting, trimming and notching shall be laid out in advance. Notching or cutting of any structural member or building surface shall not proceed without specific approval from the Engineer. Cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment shall be carefully conducted. The Contractor shall restore surfaces neatly to new condition using skilled craftsmen of the trades involved at no additional cost to the Owner.

H. Maintain the premises free from accumulation of waste material or rubbish on a daily basis. Upon daily completion of work, remove materials, scraps, and debris from the premises and from the interior and exterior of all devices and equipment.

I. Follow and adhere to all manufacturers’ instructions for handling, receiving, installation, and commissioning requirements prior to energizing the equipment. After energizing the equipment, the Contractor shall provide qualified technicians or manufacturer's services for troubleshooting, re-programming, and calibration of equipment.

J. Vacuum clean the interior of all motor control centers, panelboards, junction boxes and other enclosures supplied under this project containing fiber optic equipment to remove all dirt, metal chips, stripped insulation, etc., from the enclosure. This cleaning shall be done prior to energizing the device initially and a second time immediately prior to the final acceptance inspection.

K. After all other work has been accomplished, all work areas and all other fiber optic equipment shall be cleaned of all dust, dirt, grease, plaster, paint or other marks, by the Contractor.

3.02 INSTALLATION

A. Material and Equipment Installation:

1. Follow the manufacturer's installation recommendations unless otherwise indicated on the Contract Drawings. Keep a copy of the manufacturer's installation instructions available at the job site for review at all times.
2. All fiber optic equipment and appurtenance facilities that are separately mounted or anchored shall be so installed as to be in conformance to all requirements of the Uniform Building Code both for vertical and seismic loading.
3. Locate and install all equipment such that it can be readily accessible for operation and maintenance. The Owner reserves the right to require minor changes in location of panels or equipment, prior to roughing in, without incurring any additional costs or charges.
4. Equipment supports/anchors and restrainers shall meet the seismic requirements specified in these specifications.

B. Cable Installation:

1. The cable shall be installed by licensed electricians using industry standard practices for fiber optic installation. The following are minimal generic guidelines that must be observed and performed.
2. The interduct (installed by others) shall be blown down with compressed air for 5 minutes per segment (between pull boxes) or until the run is clear, whichever is longer.
3. All interduct segments shall be “proofed” by passing a rigid mandrel, 90 percent of the size for the interduct or conduit, (typically 1.8 inches for a 2-inch PVC interduct) through the interduct or conduit. The proofing shall be performed by pushing a mandrel through the interduct (or conduit) segment. The Contractor shall record the distance of any obstructions prior to fiber optic installation. These records shall be submitted prior to cable installation. No compensation for cable damage will be considered or approved unless the segment was proofed prior to installation. If an obstruction is detected and unable to be cleared, the Contractor shall perform a subsequent re-test under observation of the Engineer. The Contractor shall allow up to three of these observed re-tests under this contract. During the mandrel operations, a table of distances from pull box to pull box shall be noted to allow for cable installation planning.
4. Pulling Calculations including distance, lubrication amounts, maximum and expected pulling tensions per segment(s) shall be submitted and approved prior to cable installation.
5. Upon completion of the mandrel testing and collection of pull distances, the Contractor shall set up a meeting between the Contractor, Engineer and the Owner to review results and present the installation plan. At this meeting, any issues or traffic control shall be discussed and resolved.
6. Fiber Optic Cables shall be pulled in by hand from pull box to pull box. Cable lubricants shall be used in pulling the cables. The lubricant shall be approved by the fiber optic cable manufacturer. Typically, on large runs, the fiber will be pulled from the center of the run.
7. At the pull box before and after any point of intersection (or spurs) of interduct runs and approximately every 1500 feet of the interduct run, the contractor shall coil 50 feet of additional cable at these pull boxes. All pull boxes shall have at least one loop to prevent micro or macro bends by exceeding minimal bend radiuses.
8. The cable shall be kept on the factory roll, clean and away from foot or vehicular traffic. Cones, blockades and personnel shall be used to protect the cable from damage. Any cable that is run over by vehicular traffic shall be replaced by the contractor at no additional cost to the Owner.
9. All pull boxes shall be kept closed when not in use. Any open pull boxes must be barricaded or marked with cones or other acceptable means. No open pull boxes will be allowed to be left overnight without expressed Owner approval.

C. Connections: Install SC connectors per manufacturer's standard instructions. A copy of these instructions shall be onsite with the installer and available for inspection when onsite. If these instructions are not onsite, all connections made during that time will be removed and then re-installed after the instructions are onsite. This additional work shall be performed at no cost to the Owner.

D. Fusion Splices: All fusion splices shall be witnessed by the Engineer or Owner's representative. A copy of the splice instructions shall be onsite with the installer and available for inspection. If these instructions are not onsite, all splices made during this time will be removed and then re-installed after the instructions are onsite. This additional work shall be performed at no cost to the Owner.

3.03 TESTING

A. General Requirements:

1. Perform a complete test of the installed project to demonstrate that the fiber optic system is functional as shown on the Contract Drawings.
2. Provide labor, instruments, and other material to complete the tests.
3. Submit a test report including the tests that were performed and the results.
4. Perform all tests, excluding Factory Testing, in the presence of the Owner's representative.
5. The tests shall include Factory Tests, Fiber Loss Tests and Optical Time Domain Reflectometer (OTDR) Testing.
6. All instruments shall be NIST certified within one year of the test being conducted. These certifications shall be included in the submittal for the test procedures and again with the actual test reports.
7. At least 2 weeks prior to the start of field testing, submit a test procedure for each type of test, sample test forms, and NIST calibration or Certifications for each instrument.

B. Factory Tests (FT):

1. Factory tests shall be performed to demonstrate that the cables have been fabricated properly and are working correctly. Submit a test report indicating that the Factory Test was performed for Engineer's review. No cables shall be released for installation until the FT has been reviewed and approved by the Engineer.
2. All cabled optical fibers shall be 100 percent attenuation tested using an OTDR. The attenuation of each fiber shall be shipped along with the reel in a cable packet.

C. Fiber Optic Link Loss Budget:

1. Prepare a fiber optic link loss budget based on actual cable used and distances, connectors and splices on each fiber run. This budget information shall be in an excel spreadsheet format similar to the Fiber Optic Link Loss Budget form shown in Appendix A.
2. The fiber optic link loss budget must be submitted and approved prior to performing OTDR testing.

D. Fiber Loss Tests (FL):

1. Upon completion of a fiber cable run in which the cable has been installed in a fiber termination enclosure and connectors terminated, the individual fibers will be tested using a fiber loss kit with a 1310-nm laser source.
2. Testing shall be performed with both 1310 and 1550-nm laser light sources at one end and an optical loss meter at the other end of each fiber. Record results for each cable. If any cables are outside expected loss results, this shall be recorded including steps taken to correct these issues. Final fiber loss results shall be indicated on the test form. If unable to correct, the cable shall be replaced at no expense to the Owner.

3. The FL includes testing of all fibers installed under this contract including fibers that are for future splicing or future use.
4. Loss Testing shall be conducted from each end of a fiber and all results recorded on a form similar to the Fiber Loss Test Form shown in Appendix A.

E. Optical Time Domain Reflectometer Testing (OTDR):

1. The Contractor shall perform the Optical Time Domain Reflectometer (OTDR) Testing after he has delivered written notice to the Engineer that the Fiber Loss Tests has been successfully completed. This notice shall be in the form of the Fiber Loss Test Report.
2. The Contractor shall inform the Engineer at least one week prior to the OTDR so that the Engineer may witness the test.
3. The OTDR includes testing of all fibers installed under this contract including fibers that are for future use and spares.
4. If any equipment or cable fails the OTDR, the Contractor shall correct the problem and shall repeat the test until it is successful. If unable to correct, the cable shall be replaced at no expense to the Owner.
5. The OTDR shall be performed in the presence of the Engineer.
6. Any OTDR testing without the Engineer or Owner personnel shall not be accepted. Any re-testing of un-witnessed testing shall be performed solely at the Contractors expense. No time extensions or additions will be accepted for this work.
7. The OTDR test unit shall be designed for use on single-mode fiber at 1310 and 1550 nm wavelength and shall be a field unit with the following characteristics:
   a. Dead zone: 49.2 feet or better
   b. Attenuation range: 15 decibels or better
   c. Distance range: 32,808.4 feet or better
   d. Accuracy: + 6.6 feet
   e. Printer: must be capable of printer or file output.
8. The OTDR test unit shall be capable of downloading the results to a PC and this file shall be provided to the Owner. Test results shall be readable via one of the following formats: pdf, xls, doc, or txt.

F. Test Reports:

1. Sample test forms and procedures for each type of test (Factory, Fiber Optic Link Loss, Fiber Loss and OTDR Summary) shall be submitted and approved prior to fiber shipment or installation as applicable.
2. Submit test results for review and approval immediately (within 1 week) after each test is completed.
3. Submit a copy of the approved test results with the O&M manual.

3.04 TRAINING

A. Instruction shall include a basic overview of fiber optic principles, safety, good practices and maintenance.

B. Hands-On Instructions shall be provided on the use of the supplied test equipment including setup, cleaning, use, common errors or mistakes, safety and other pertinent information to allow maintenance personnel to understand and use the equipment for troubleshooting and routine maintenance.

C. Provide all manuals and study materials required for the training of Owner personnel.

END OF SECTION

Appendix A

FO Link Loss Budget

FO Loss

OTDR Summary

SECTION 16140
WIRING DEVICE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide wiring devices, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 16050 – General Electrical Work, apply to this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.02 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals.

B. Shop Drawings

1. Submit complete catalog cuts of switches, receptacles, enclosures, covers and appurtenances, marked to clearly identify the proposed materials.
2. Submit documentation showing that the proposed materials comply with the requirements of NEC and U.L.
3. Submit documentation of the manufacturer's qualifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Devices shall carry the U.L. label, and shall be designed for use with stranded copper conductors.

B. Color

1. General purpose duplex receptacles and toggle switch handles shall be Brown everywhere except unless otherwise indicated.
2. Special purpose receptacles shall have a body color as indicated.

C. Receptacles and switches shall be of specification grade and shall conform to NEMA WD-1, Federal Specifications W-C-596E and W-S-896E, respectively.

2.02 LIGHTING SWITCHES

A. Toggle switches shall be AC only type switch.

1. 20A, 120/277V, Single, Double, 3-Way and 4-Way, Respectively
   a. **Leviton**: 1221-2, 1222-2, 1223-2, 1224-2
   b. **Hubbell:** HBL1221, HBL1222, HBL1223, HBL1224
   c. **Pass and Seymour:** PS20AC1, PS20AC2, PS20AC3, PS20AC4
   d. **Or Equal**
2. Lighted Handle Pilot Switch, 20A, 120/277V, Red, Single, Double, 3-Way
   a. **Hubbell:** HBL1221PL, HBL1222PL, HBL1223PL
   b. **Pass and Seymour:** PS20AC1-RPL7, PS20AC2-RPL, PS20AC3-RPL7
   c. **Or Equal**

2.03 GENERAL PURPOSE RECEPTACLES

A. Duplex receptacles shall be of the polarized 3-wire type for use with a 3-wire cord with grounded lead, and one designated stud shall be permanently grounded to the conduit system in accordance with NEC article 406.4.

B. Dry Areas

1. NEMA Configuration #5-20R: duplex receptacle rated 125V, 20A

a. **Leviton:** #5362
b. **Hubbell:** #HBL5362
c. **Pass and Seymour:** #5362A
d. **Or Equal**

2. NEMA Configuration #5-30R single receptacle rated 125V, 30A

a. **Leviton:** #5371
b. **Hubbell:** #HBL9308
c. **Or Equal**

C. Damp/Wet Areas

1. Receptacles for damp/wet locations shall be weather-resistant with extra duty, in-use listed covers in accordance with NEC Article 406.8.

D. GFCIs

1. Ground-fault circuit-interrupting receptacles (GFCIs) shall be installed at the indicated locations and as required by the NEC.
2. GFCIs shall be duplex receptacles, of specification grade, and tripping at 5 mA.
3. GFCI ratings shall be 125V, 20 amperes, NEMA WD-1, Configuration 5-20R, and capable of interrupting 5,000 amperes without damage.
4. GFCIs shall be weather resistant-listed in accordance with NEC Article 406.8.
5. Feed-through-type GFCIs serving standard receptacles will not be permitted.

a. **Leviton:** G5362-WT
b. **Hubbel:** GFR5362SG
c. **Or Equal**

2.04 ENCLOSURES AND COVERS

A. Surface-mounted switches and receptacles shall be housed in FD-type weatherproof conduit fittings.

B. Switch and receptacle covers on surface-mounted boxes shall be constructed of die-cast copper-free aluminum.

1. **Appleton**: FSK
2. **Crouse-Hinds**: DS185 and WLRD-1
3. **Hubbell Killark**: FZ and FC
4. **Or Equal**

C. In finished areas, switch and receptacle covers shall be constructed of stainless steel.

D. Wet Locations

1. Receptacles in wet locations shall be provided with a hinged non-metallic Clear cover/enclosure marked "Suitable for Wet Locations when in use" and "UL Listed."
2. Provide a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base.

a. **Appleton**: WCIU
b. **Crouse-Hinds**: TP74
c. **Hubbell TayMac:** Extra Duty
d. **Or Equal**

2.05 WELDING RECEPTACLES

A. Welding receptacles shall be rated 60 amperes, 600 VAC, 3-wire, 4-pole, heavy-duty circuit-breaking-type, complete with an outlet box and connected for 480-volt service.

B. Furnish a matching plug for every 3 receptacles.

1. **Appleton**: Powertite ADRE6034, with plug ACP6034
2. **Crouse Hinds**: Arktite ARE6424, with plug APJ6485.
3. **Hubbell Killark**: Versamate VR6034 with plug VP6034
4. **Or Equal**

2.06 RECEPTACLE – SPECIAL PURPOSE

A. Special purpose receptacles shall be provided with the ratings and number of poles as indicated or required for the proposed purpose.

B. Provide a matching plug with cord-grip features with each special purpose receptacle.

2.07 FLOOR RECEPTACLE BOXES

A. Floor receptacles and jacks shall be installed in rectangular floor boxes.

B. The floor boxes shall be 1-, 2- or 3-gang as required for each installation.

C. The floor boxes shall be constructed of cast iron and sized for the depth of the floor slab.

D. Carpet flanges shall be provided.

E. Covers shall be constructed of brass, with openings for duplex receptacle voice and data jacks.

F. Floor boxes shall be as manufactured by **Hubbell** or equal

2.08 NAMEPLATES

A. Provide nameplates or equivalent markings on the switch enclosures to indicate the ON and OFF positions of each switch.

B. ON and OFF for 3-way or 4-way switches will not be accepted.

C. Provide receptacles for special purposes with nameplates indicating their use.

D. Nameplates shall meet the requirements of Section 16050 – General Electrical Work.

PART 3 - EXECUTION

3.01 GENERAL

A. Perform WORK in accordance with the requirements of the NEC.

3.02 CONNECTION

A. Rigidly attach wiring devices in accordance with the NEC and as indicated, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets centered under or on the device, unless otherwise indicated.

C. Receptacles indicated to be powered by uninterruptible power supplies (UPS) shall have a nameplate installed directly above the receptacle that reads:

1. (first line) “UPS-POWERED”
2. (second line) “NO TOOLS”

D. Nameplates shall meet the requirements of Section 16050 – General Electrical Work, General, and shall consist of a red plate with white letters a minimum of 1/4 inch tall.

3.03 GROUNDING

A. Devices, including switches and receptacles, shall be grounded in accordance with NEC, Article 250, and Section 16450 – Grounding.

B. Switches and associated metal plates shall be grounded through the switch mounting yoke, outlet box, and raceway system.

C. Flush Receptacles

1. Flush receptacles and their metal plates shall be grounded through positive ground connections to the outlet box and grounding system.
2. Maintain the ground to each receptacle by a spring-loaded grounding contact to the mounting screw, or by a grounding jumper, each making a positive connection to the outlet box and grounding system at all times.

D. Receptacles served from an uninterruptible power supply shall be provided with an isolated grounding conductor from the serving power panelboard.

3.04 FIELD TESTING

A. Provide checkout, field, and functional testing of wiring devices in accordance with Section 16050 – General Electrical Work.

B. Test each receptacle for polarity and ground integrity, using a standard receptacle tester.

END OF SECTION

SECTION 16150
ELECTRIC MOTORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide electric motors, accessories, and appurtenances complete and operable, in conformance to the Contract Documents.

B. The provisions of this Section apply to low voltage 3 phase, AC squirrel cage induction motors throughout the Contract Documents, except as indicated otherwise.

C. The CONTRACTOR shall assign to the equipment supplier the responsibility to select suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review by the ENGINEER. Such review will consider future availability of replacement parts and compatibility with driven equipment

1.02 RELATED WORK

A. Section 01300 Submittals

B. Section16050 General Electrical Work

C. Section 16155 Low-Voltage Motor Control Centers

D. Section 16260 Variable Frequency Drive Units

1.03 REGULATORY AGENCIES AND STANDARDS

A. Regulatory Agencies: Testing shall conform to the latest provisions of the following agencies:

1. NEC (NFPA 70) National Electrical Code: 2023 Edition

B. Standards: Where referenced in these specifications or on the drawings, the publications and standards of the following organizations apply:

1. NEMA National Electrical Manufacturers Association

a. NEMA MG-1, Motor and Generator Standards

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 01300 - Submittals.

B. Complete motor data shall be submitted with the driven machinery Shop Drawings. Motor data shall include:

1. Machine name and specification number of driven machines
2. Motor manufacturer
3. Motor type or model and dimension drawing. Include motor weight.
4. Nominal horsepower
5. NEMA design
6. Enclosure
7. Frame size
8. Winding insulation class and temperature rise class
9. Voltage, phase, and frequency ratings
10. Service factor
11. Full load current at rated horsepower for application voltage
12. Full load speed
13. Guaranteed minimum full load efficiency and nominal efficiencies at 1/2 and 3/4 load.
14. Type of thermal protection or overtemperature protection, where included

15. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable
16. Bearing data. Include recommendation for lubricants of required type bearings.
17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery. Provide shaft grounding details and information. Provide insulated bearing details and information.
18. Power factor at 1/2, 3/4 and full load.
19. Recommended size for power factor correction capacitors to improve power factor to 0.95 percent lagging when operated at full load.

C. If water cooling is required for motor thrust bearings, the Shop Drawing submittals shall indicate this requirement.

1.05 FACILITY OPERATION AND MAINTENANCE MANUALS

A. Submit complete operation and maintenance manual in accordance with the requirements of Section 01680 – Facility Operation and Maintenance Manuals.

PART 2 - MATERIALS

2.01 GENERAL

A. Electric motors driving identical machines shall be identical.

B. Electric motors shall comply with NEMA MG-1 - Motor and Generator. Motors used with adjustable frequency drives shall comply with NEMA MG-1, Part 31, and shall be clearly identified as “Inverter Duty.”

C. Maximum motor loading shall be equal to nameplate horsepower rating or less, exclusive of service factor and be verifiable from the submittal data of the driven machinery.

D. Electric motors shall be NEMA Design B unless otherwise indicated. Starting torque or breakdown torque be less than the value in NEMA MG 1 shall not be permitted. Motors shall be suitable for the indicated starting method.

E. Motor Voltage Ratings

1. Low voltage motors shall have voltage ratings in accordance with the following, unless otherwise indicated:
   a. Motors below 1/2 HP shall be rated 115 volts, single phase, 60 Hz. Dual voltage motors rated 115/230 volts, 115/208 volts, or 120-240 volts are acceptable, provided leads are brought out to the conduit box.
   b. Motors 1/2 HP and larger shall be rated 460 volts, 3 phase, 60 Hz. Dual voltage motors rated 230/460 volts or 208/230/460 volts are acceptable, provided every lead is brought out to the conduit box.

F. Insulation

1. Three phase motors shall be provided with Class F insulation, rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated, without exceeding Class B temperature rise limits stated in NEMA MG 1-12.44.
2. Single phase motors shall have Class F insulation with temperature rise not to exceed the insulation class.
3. Motors to be operated from adjustable frequency drives shall be provided with insulation systems to withstand 1600-volt spikes, with dV/dT as defined in NEMA MG 1-31.

4. The adjustable frequency drive manufacturer shall coordinate with the motor manufacturer to determine when additional dV/dT protection is required. Where required, it shall be furnished and installed as per the manufacturer's written instructions.

G. Motors (Non-hazardous locations)

1. 50 HP or smaller shall be totally enclosed, fan cooled (TEFC) with a Service Factor of 1.15 unless otherwise indicated.
2. Motors 50 HP and greater shall be TEFC, with a service factor of 1.15.

H. Motors (hazardous locations)

1. Motors for use in hazardous locations shall have enclosures suitable for the classification indicated. Such motors shall be U.L. listed and be stamped as such.

I. Motors larger than 50 HP installed outdoors or in unheated areas shall be provided with 120-volt AC space heaters, wired to a terminal strip in a low voltage motor junction box. If provided by the manufacturer when not specified, the manufacturer shall not require that they be connected or the CONTRACTOR shall connect them at no extra cost to the OWNER, in order to keep the warranty in force.

J. NEMA Premium Efficiency Motors

1. Motors with a nameplate rating of 1 HP and larger shall be NEMA premium efficient units. Motors shall be stamped with the efficiency on the nameplate with the caption "NEMA Nominal Efficiency" or "NEMA Nom. Eff." Such motors shall have efficiencies determined by the test as set forth in ANSI/IEEE 112 - Standard Test Procedure for Polyphase Induction Motors and Generators, Method B.
2. Efficiency: Nominal efficiency and minimum efficiency shall be defined in accordance with the following tables. Both efficiencies shall be included in the Shop Drawing submittal.

OPEN DRIP-PROOF (ODP)						
FULL-LOAD EFFICIENCIES OF NEMA PREMIUM EFFICIENCY MOTORS RATED 600 VOLTS OR LESS						
	2 POLE		**4 POLE**		**6 POLE**	
HP	**Nom. Effic.**	**Min. Effic.**	**Nom. Effic.**	**Min. Effic.**	**Nom. Effic.**	**Min. Effic.**
1	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	86.5	84.0
2	85.5	82.5	86.5	84.0	87.5	85.5
3	85.5	82.5	89.5	87.5	88.5	86.5
5	86.5	84.0	89.5	87.5	89.5	87.5
7.5	88.5	86.5	91.0	89.5	90.2	88.5
10	89.5	87.5	91.7	90.2	91.7	90.2
15	90.2	88.5	93.0	91.7	91.7	90.2
20	91.0	89.5	93.0	91.7	92.4	91.0
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	94.1	93.0	93.6	92.4
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.0	94.1	94.5	93.6
100	93.6	92.4	95.4	94.5	95.0	94.1
125	94.1	93.0	95.4	94.5	95.0	94.1
150	94.1	93.0	95.8	95.0	95.4	94.5
200	95.0	94.1	95.8	95.0	95.4	94.5
250	95.0	94.1	95.8	95.0	95.8	95.0
300	95.4	94.5	95.8	95.0	95.8	95.0
350	95.4	94.5	95.8	95.0	95.8	95.0
400	95.8	95.0	95.8	95.0	--	--
450	96.2	95.4	96.2	95.4	--	--
500	96.2	95.4	96.2	95.4	--	--

Source: NEMA MG1 - 2016, Table 12-12

TOTALLY ENCLOSED - FAN COOLED (TEFC)						
FULL-LOAD EFFICIENCIES OF NEMA PREMIUM EFFICIENCY MOTORS RATED 600 VOLTS OR LESS						
	2 POLE		4 POLE		6 POLE	
HP	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.
1	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	87.5	85.5
2	85.5	82.5	86.5	84.0	88.5	86.5
3	86.5	84.0	89.5	87.5	89.5	87.5
5	88.5	86.5	89.5	87.5	89.5	87.5
7.5	89.5	87.5	91.7	90.2	91.0	89.5
10	90.2	88.5	91.7	90.2	91.0	89.5
15	91.0	89.5	92.4	91.0	91.7	90.2
20	91.0	89.5	93.0	91.7	91.7	90.2
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	93.6	92.4	93.0	91.7
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.4	94.5	94.5	93.6
100	94.1	93.0	95.4	94.5	95.0	94.1
125	95.0	94.1	95.4	94.5	95.0	94.1
150	95.0	94.1	95.8	95.0	95.8	95.0
200	95.4	94.5	96.2	95.4	95.8	95.0
250	95.8	95.0	96.2	95.4	95.8	95.0
300	95.8	95.0	96.2	95.4	95.8	95.0
350	95.8	95.0	96.2	95.4	95.8	95.0
400	95.8	95.0	96.2	95.4	--	--
450	95.8	95.0	96.2	95.4	--	--
500	95.8	95.0	96.2	95.4	--	--

Source: NEMA MG1 - 2016, Table 12-12

K. Two speed motors shall be of the 2-winding type.

L. Motor Capacity

1. Motor size shall be de-rated from nameplate values as follows:

a. Ambient Temperature

- For ambient temperatures up to but not exceeding 40 degrees C, no derating is required.
- For ambient temperatures exceeding 40 degrees but less than 50 degrees C, de-rate nameplate HP ratings to 85 percent.

b. Site Altitude: No derating is required for altitudes less than 3300 feet (1000 meters). Higher altitudes require the following derating factors:

Altitude	Derating Factor
3,300 to 5,000 ft	97 percent
5,001 to 6,600 ft	94 percent
6,601 to 8,300 ft	91 percent
8,301 to 9,900 ft	88 percent
9,901 to 11,500 ft	85 percent

2. Increased circuit breaker, magnetic starter, and conductor and conduit capacities required for motors larger than the indicated sizes shall be provided as part of the WORK.

2.02 ACCESSORY REQUIREMENTS

A. General: Horizontal motors 3 HP and larger and every vertical motor shall have split-type cast metal conduit boxes. Motors shall be provided with oversized conduit boxes. Where conduit sizes indicated do not match the motor terminal box, the CONTRACTOR shall provide means to accommodate the motor requirements. Motor boxes other than open drip-proof shall be gasketed.

B. Lifting Devices: Motors weighing 265lb (120Kg) or more shall have suitable lifting eyes for installation and removal.

C. Special Requirements: The CONTRACTOR shall refer to individual equipment specifications for special requirements such as motor winding thermal protection or multi-speed windings.

D. Grounding Lugs: Provide motor grounding lug suitable to terminate ground wire, sized as indicated.

E. Nameplate: Motors shall be fitted with permanent stainless-steel nameplates indelibly stamped or engraved with NEMA Standard motor data, in conformance with NEMA MG-1-10.40. Inverter duty motors shall be clearly identified as such.

F. Where motors are indicated by elementary schematics or specifications to have zero speed switches, the switches shall be factory mounted integral to the motors. Switches shall close the contacts when the motor is at zero speed.

G. Inverter duty motors shall be provided with shaft grounding rings. Rings shall be factory installed, and shall be manufactured by **Aegis**, or equal. The motor warranty shall include coverage against VFD-induced bearing damage or failure.

2.03 MOTOR THERMAL PROTECTION

A. Thermostats: Where indicated or specified, winding thermostats shall be snap action, bi-metallic, temperature-actuated switch. Thermostats shall be provided with one normally closed contact. The thermostat switch point shall be pre-calibrated by the manufacturer. All inverter duty motors shall be provided with winding thermostats, unless RTDs are specified. All explosion-proof motors shall be provided with winding thermostats.

2.04 MOTOR BEARINGS

A. Vertical Motors

1. Provide bearings of the type and size required to meet the thrust loading requirements with a rated B-10 life of 100,000 hours as defined by the Anti-Friction Bearing Manufacturers Association (AFBMA).
2. Bearings for motors 75 HP and larger shall be oil lubricated and contained in an oil reservoir with oil sight level gage and oil fill and drain openings with plugs.
3. Equip grease lubricated bearings with fittings in each bearing housing. Fittings shall be accessible without removals of any covers or guards. Provide drains to prevent over lubrication.

B. Horizontal Motors:

1. General: Equip motors larger than one (1) HP with end single shielded bearings of either the anti-friction or sleeve type with a rated B-10 life of 100,000 hours as defined by the AFBMA.
2. Anti-Friction Type: Grease lubricated type with sealed end caps to prevent grease from migrating to the bearing exterior. Provide with an excess-grease reservoir located outboard of the bearing and provisions for purging old grease.
3. Sleeve Type: Oil lubricated type contained in an oil reservoir with oil sight level gage and oil fill and drain openings with plugs. Provide bearings with shaft seals and pressure-equalizing vents to prevent oil from migrating to the motor windings.

C. Inverter Duty Motors: Provide an insulated bearing to prevent circulating bearing currents.

2.05 CONNECTION BOXES

A. Provide motors with NEMA MG-1 type I connection boxes made of fabricated steel or cast-iron construction compatible with the motor specified. Provide motors larger than 150 Hp with NEMA MG-1 type II connection boxes. Provide boxes with gaskets between the box and motor and between the box and cover. Boxes shall be capable of rotation in 90° increments. Align boxes for bottom conduit entry.

B. Provide an auxiliary terminal box for terminating auxiliary and protective devices lead wires.

2.06 MANUFACTURERS, OR EQUAL

A. **U.S. Motors/Nidec**

B. **Baldor**

C. **WEG**

PART 3 - EXECUTION

3.01 INSTALLATION

A. Motor installation shall be performed in accordance with the motor manufacturer's written recommendations and the written requirements of the manufacturer of the driven equipment. Shaft grounding devices shall be connected to the grounding system in accordance with the manufacturer's recommendations.

B. Related electrical WORK involving connections, controls, switches, and disconnects shall be performed in accordance with the applicable sections of Division 16.

3.02 STORAGE

A. Protect motors from exposure of elements for which they are not designed. Install and energize temporary electrical service to motors with electrical heaters.

B. Unless protected by manufacturer's packing, upon delivery, carefully wrap each motor in three layers of 8 mil minimum polyethylene. Secure the wrap with adhesive tape to minimize the entrance of moisture. For base mounted motors, wrap the entire assembly.

3.03 FACTORY TESTING

A. Motors rated 100 HP and larger shall be factory tested in conformance with IEEE 112, IEEE 43 - Recommended Practice for Testing Resistance of Rotating Machinery, and NEMA MG-2. Except where specific testing or witnessed shop tests are required by the specifications for driven equipment, factory test reports may be copies of routine test reports of electrically duplicate motors. Test report shall indicate test procedure and instrumentation used to measure and record data. Test report shall be certified by the motor manufacturer's test personnel and be submitted to the ENGINEER.

3.04 FIELD TESTING

A. The CONTRACTOR shall perform the following field tests (see also Section 16950 – Electrical Testing):

1. Inspect each motor installation for any deviation from rated voltage, phase, frequency, and improper installation.
2. Visually check for proper phase and ground connections. Verify that multi-voltage motors are connected for proper voltage. Verify shaft grounding devices are properly grounded.
3. Check winding and bearing temperature detectors and space heaters for functional operation.
4. Test for proper rotation prior to connection to the driven equipment.
5. Visually check that motor overload heaters are properly sized and that MCP breaker settings are correct for the motor installed.
6. Test insulation (megger test) of new and re-used motors in accordance with NEMA MG-1. Test voltage shall be 1000 VAC plus twice the rated voltage of the motor.

END OF SECTION

SECTION 16155
LOW-VOLTAGE MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide motor control centers (MCCs), complete and operable, in accordance with the Contract Documents.

B. The PLC Section of the MCC shall be assembled and wired by a UL 508C panel assembly shop separate from the MCC manufacturer, and then interconnected to the remainder of the MCC in the field by the Electrical Subcontractor.

C. The requirements of Section 16050 – General Electrical Work, apply to the WORK of this Section.

D. In the event that provided motors are of greater horsepower than the indicated motors, revise the raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased motor horsepower in accordance with Section 26 05 10 – Electric Motors.

E. Single Manufacturer

1. The MCCs shall be the end product of one manufacturer in order to standardize appearance, operation, maintenance, spare parts, and manufacturer's services.

2. This requirement, however, does not relieve the CONTRACTOR of overall responsibility for the WORK.

F. Coordination

1. The equipment provided under this Section shall operate the electric motor driver with the driven equipment as indicated under other equipment Sections.

2. The MCC manufacturer shall be provided with the following information, at a minimum:

a. Section 16050 – General Electrical Work

b. Section 16460 – Electric Motors

c. Section 16485 – Industrial Control Panels

d. Section 16950 – Electrical Tests

e. Electrical Contract Drawings

1.02 SUBMITTALS

A. Furnish submittals in accordance with Section 16050 – General Electrical Work.

B. Furnish Custom-prepared Shop Drawings.

1. The CONTRACTOR shall provide custom-prepared shop drawings with terminal numbers, wiring labels, component data, and all associated electrical components required by the CONTRACT DOCUMENTS.

a. Manufacturer supplied shop drawings shall be rejected without review IF NOT customized to meet CONTRACTO DOCUMENTS.

C. Furnish the following equipment information in the Shop Drawings:

1. NEMA rating and color of enclosure

2. horizontal and vertical bus ampacities, voltage rating, interrupting capacity, and materials of construction

3. ground bus size and material of construction

4. conduit entrance provisions

5. main incoming line entry provision (top or bottom)

6. control unit nameplate schedule
7. circuit breaker types, frames, and settings
8. starter NEMA sizes, auxiliary contact provisions, and coil voltage
9. relays, timers, pilot devices, control transformer VA and fuse sizes
10. MCC Ladder Diagrams
    a. Furnish custom elementary schematic ladder diagrams for each compartment.
    b. The ladder diagrams shall include remote devices.
    c. Submittals not meeting these requirements will not be reviewed further and will be returned to the CONTRACTOR.
11. PLC Diagrams
    a. Furnish custom elementary schematic ladder diagrams developed by the UL 508C panel assembly shop that is preparing the PLC section.
    b. The ladder diagrams shall include both remote and field devices, wire numbers, terminal numbers, and wire colors.
    c. The diagrams shall include and indicate each device and terminal, as well as wiring provided by the MCC Manufacturer.
    d. Submittals not meeting these requirements will not be reviewed further and will be returned to the CONTRACTOR.
12. MCC Internal Connections
    a. Furnish the MCC internal connection list and diagram developed by the UL 508C panel assembly shop that is preparing the PLC Section.
    b. The list and diagram shall detail each wiring connection between the PLC Section and each compartment provided by the MCC Manufacturer, and shall specifically include and indicate the terminals and wire numbers on both ends of each internal connection wire.
    c. Submittals not meeting these requirements will not be reviewed further and will be returned to the CONTRACTOR.
13. Short circuit rating of the complete assembly
14. Replacement parts lists and operation and maintenance procedures
15. Seismic design certification of the anchoring system in accordance with Section 16070 – Seismic Restraint and Supports.
16. Time-current curves for protective devices
17. RVSS and VFD Equipment Information
    a. name of starter and drive manufacturer
    b. type and complete model number
    c. assembly drawing and nomenclature, including enclosure dimensions, mounting and anchoring details, and internal layout
    d. detailed schematics, including external wiring connections
    e. maximum heat dissipation capacity in kW
    f. altitude de-rating information
18. Factory test data certifying compliance with requirements of similar equipment from the same manufacturer

D. Furnish an Owner's Manual, including:

1. manufacturer's 2-year warranty

2. field test report

E. Furnish the Manufacturer's Service Representative's resume, including the following documentation:

1. copy of the proposed representative's Factory Training Certificate
2. number of years experience servicing the manufacturer’s MCCs and VFDs
3. a statement that the individual is authorized to inspect, test and perform field service and repairs

F. Spare Parts List

1. Furnish spare parts information for parts required by this Section as well any other spare parts recommended by the MCC manufacturer.

G. Startup and Testing Report

1. Within 15 days after completion of startup and testing, the CONTRACTOR shall submit a report for the MCC.
2. The report shall contain the following documentation:
   a. the device name, serial number, rating, and complete model number of each MCC
   b. a complete listing of all tests performed and the results of each test
   c. a complete listing of all circuit breaker and overload settings, fuse ratings, settings, setpoints and configuration information for VFDs and equipment or devices with adjustable settings
   d. documentation for training that was provided to the OWNER’s personnel, including topics covered, instructor's name and contact information, and a list of attendees

PART 2 - PRODUCTS

2.01 GENERAL

A. The manufacturer of the low-voltage motor control center shall also manufacture at least the following:

1. molded case circuit breakers, up to and including 225 ampere frame size
2. disconnect switches
3. magnetic motor starters
4. control and timing relays rated at 600 volts AC
5. pushbuttons, lights and selector switches, including remote mounted control stations
6. meters, including ammeter, voltmeter, and solid-state metering devices

B. Single Manufacturer

1. Devices of the same type shall be products of the same manufacturer.
2. This requirement applies to control devices, custom-fabricated equipment, and insofar as practical to equipment manufactured on a production basis.

C. Lighting transformers and panelboards shall be in accordance with the requirements of Section 16470 – Panelboards and General Purpose Dry-Type Transformers.

D. Motor control centers shall conform to the standards for NEMA Class IIS, Type B diagrams and wiring.

E. The PLC Section shall conform to the standards for NEMA Class II, Type B diagrams and wiring.

F. MCC Schedule

MCC DESIGNATION	LOCATION

MCC-10	CONTROL BUILDING

2.02 DESIGN, CONSTRUCTION, AND MATERIAL REQUIREMENTS

A. The motor control centers shall be 600-volt class and suitable for operation on a 3-phase, 60-Hz system.

B. The system operating voltage and number of wires shall be as indicated.

C. Power

1. The motor control center shall receive power from a 3-phase, wye-connected 277/480-volt MSB with a grounded neutral.
2. Power distribution from the MCC shall be 480-volt, 3-phase, 3-wire.
3. The MCC shall include provision for termination of an incoming neutral conductor in conformance to NEC requirements for service entrance.

D. Enclosure

1. The enclosure shall be of NEMA Type NEMA-12.
2. The variable frequency drive (VFD) and solid-state soft starter (RVSS) compartments may be of NEMA Type 1, gasketed, provided that ventilation inlet openings are covered by externally replaceable dust filters.
3. Compartment doors shall be interlocked with compartment circuit breakers, fitted with a maintenance override.
4. Latches for panelboard compartments shall have butterfly heads or another hand operable method that does not require tools to operate.

E. Size and Arrangement

1. Motor control centers shall be configured as mechanical groupings of control center units, assembled into a lineup of control center sections.
2. Each control section shall be nominally 90 inches tall by a minimum of 20 inches deep.
3. MCCs shall be designed to not exceed the indicated spatial requirements, including spaces, spares, and future compartments.
4. MCCs shall be subject to rejection if they exceed the indicated lengths, where allotted space is critical.
5. Equipment within the MCC may be rearranged at the discretion of the manufacturer, providing that the MCC includes the spares, space, and future provisions as indicated.
6. Switches and circuit breakers used as switches shall be located such that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, will not be more than 6 feet, 7 inches above the floor, including the height of the concrete pad.

F. Components

1. Busses

a. Provide a continuous copper ground bus, full width of the motor control center line-up.

b. Horizontal Busses

- The main horizontal bus shall be of tin-plated copper, and located within an isolated compartment.
- The bus shall be rated for 600 amperes minimum, but in no case less than the main lug or main breaker frame size.

c. Vertical Busses

- The vertical bus in each section shall consist of a single tin-plated copper conductor per phase, with a current capacity of not less than 300 amps.
- The vertical bus shall be completely isolated and insulated, and shall extend the full height of the section wherever possible.

d. Power buses shall be braced to withstand 65,000 amperes, minimum.

e. The PLC section shall have neither a horizontal nor a vertical bus, in order to allow the maximum room for control components.

2. Wireways

a. Provide a separate vertical wireway adjacent to each vertical unit, covered by a hinged door.

b. Each individual unit compartment shall be provided with a side barrier to permit pulling wire in the vertical wireway without disturbing adjacent unit components.

c. Full height (72-inch) compartments or sections are not required to have a separate wireway.

3. Power, control, and signal fuses shall have blown fuse indicators.

4. Control wires shall be color coded in accordance with Section 16120 – Wire and Cabling.

G. Cabinets

1. Structural members shall be fabricated of not less than 12-gauge steel, and side and top panels and doors shall be fabricated of not less than 14-gauge steel.

2. Spaces designated as SPACE or BLANK shall include blank hinged doors and vertical bus bars.

3. Control units inside compartments shall be clearly identified with tags or stencil markings.

4. Identification

a. Each control unit, including spares, spaces and blanks, lights, and devices shall be identified by an engraved nameplate.

b. Identification shall include the indicated circuit number.

c. Each motor control center shall be fitted with the manufacturer's nameplate which shall include the NEMA Standard electric rating and other pertinent data, including manufacturer, sales order number, date of manufacture, and place of manufacture.

5. Where "L" or "U" shaped MCC layouts are indicated, corner compartments shall have similar current and short circuit ratings as functional compartments.

6. Fans, heat exchangers, transformers, capacitors, junction boxes, and other devices shall not be mounted on the outside of the motor control center enclosure.

7. Protective Coating

a. The finish for motor control center shall be light grey: ANSI 61 or 49.

b. The panels shall be coated with 2 coats of primer inside and out, and 2 coats of enamel finish.

c. External colors other than ANSI 61 or 49 will not be accepted.

2.03 MAIN AND FEEDER CIRCUIT BREAKERS (480 V)

A. Circuit breakers having a frame size of 150 amperes or less shall be molded-case type with thermal magnetic non-interchangeable, trip-free, sealed trip units.

B. Circuit breakers with a frame size of 225 amperes to 1,200 amperes shall be molded case with interchangeable thermal, and adjustable magnetic trip elements with the following adjustments:

1. long-time setting (by changing the unit)
2. long-time delay
3. short-time setting
4. short-time delay
5. instantaneous setting
6. ground-fault setting
7. ground-fault delay

C. The interrupting capacity of the main and feeder branch circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes.

D. Service disconnects rated 1000 amps or greater shall provide for ground fault protection of the equipment.

E. Circuit breaker disconnect operators shall be capable of accommodating 3 padlocks for locking in the OPEN position.

F. Circuit breaker auxiliary contacts shall be furnished where indicated.

2.04 MOTOR STARTERS

A. Motor starters shall be mounted in standard motor control center assemblies, arranged as indicated.

B. Components

1. Each motor starter unit shall consist of a combination magnetic contactor and short circuit protective device, mounted in a completely enclosed cubicle.
2. The short circuit protective device shall be an instantaneous, magnetic only circuit breaker: **Cutler-Hammer Type HMCP, G.E. Mag-Break Motor Circuit Protector**, or equal.
3. Circuit breakers provided as part of a motor starter unit shall be capable of being padlocked in the OPEN position.
4. Resetting of thermal overload elements shall be possible with the unit door closed.
5. Provide 3-phase overload trip units to suit the full load current of the equipment installed, and the trip unit shall be adjusted as required for power factor correction capacitors.

C. Magnetic Starters

1. Magnetic starters shall have auxiliary contacts as indicated, including N-O and N-C contacts as indicated, plus one each spare N-O and N-C contact.
2. The combination motor starters shall be drawout-type for Size 5 and below.
3. The fixed-type unit assembly shall be constructed such that it can be easily removed from its panel after disconnecting the wires to the terminal block and withdrawing from the primary bus.
4. Removal of a unit assembly shall be possible without rear access and without disturbing any other unit in the motor control center.

D. Control Power Transformer

1. Each starter unit shall have its own control power transformer, with a 115-volt grounded secondary.
2. Provide one secondary fuse and 2 primary fuses.
3. Control power transformers shall be sized to accommodate the indicated control devices.
4. Local control devices shall be mounted independently of the cover door.
5. Starters shall have a local GREEN RUN indicator, and a RED OFF indicator to indicate the presence of control power when the motor is not energized.

6. Starters shall be provided with elapsed time meters, HAND-OFF-AUTO selector switches, and other devices as indicated.
7. Cubicle control wires shall be terminated at a pull-apart disconnecting terminal block located at the cubicle.

E. Identification

1. The motor control center manufacturer shall be responsible for identifying each control wire within each motor starter unit with wrap-around permanent plastic markers.
2. Each control wire shall be identified at both ends.

F. Full-Voltage Starters

1. Full-voltage motor starter units shall be NEMA Size 1 or larger.
2. Each combination starter shall be rated for a minimum 65,000 RMS symmetrical amperes.

G. NEMA Ratings

1. Motor starters shall be designed to NEMA ratings.
2. Starters designed to IEC ratings or with dual IEC/NEMA ratings will not be accepted, either as part of an MCC, as remote starters, or as part of an equipment package.

2.05 CONTROL DEVICES

A. Metering

1. Provide solid-state metering where indicated.
2. Include CTs and PTs of ratios as indicated or as recommended by the MCC manufacturer.
3. The CT leads shall terminate on shorting type terminal blocks, and the shorting bar shall be grounded to the MCC ground bus.
4. Manufacturer, or NO EQUAL
    a. Allen Bradley – PowerMonitor 3000

2.06 POWER FAIL RELAYS

A. Provide with phase loss, low voltage and phase reversal functions. Provide adjustable trip delay, restart delay and voltage trip settings. Provide a green LED indicating NORMAL and a red LED indicating TRIP.

B. Power Fail Relay shall be EATON D65-PAR Series with Plug-in Octal rated for 480VAC, or Approved Equal

C. Provide 600V RATED socket as recommended by manufacturer.

2.07 FACTORY TESTS

A. Provide the manufacturer's standard electrical and mechanical production tests and inspections for motor control centers and their components.

B. The tests shall include electrical continuity check, dielectric tests for each circuit, and inspection for proper functioning of components including controls, protective devices, metering, and alarm devices.

2.08 SPARE PARTS

A. The CONTRACTOR shall furnish the following for each MCC:

1. Unit Control Transformer: one of each size furnished in magnetic starters installed
2. Bezels: 3 of each color installed for pilot indicators
3. Panel Lamps: one dozen of each type (form, voltage and current rating) installed
4. Control Fuses: one dozen of each type (form, voltage and current rating) installed
5. Relays: one of each type and size installed

B. Spare parts shall be identified by MCC number, type, size, and manufacturer.

2.09 MCC MANUFACTURER, NO EQUAL.

A. **Rockwell Automation - Allen Bradley Centerline 2100 Series**

PART 3 - EXECUTION

3.01 GENERAL

A. The CONTRACTOR shall install motor control centers in accordance with the manufacturer's published instructions.

B. Conduit installation shall be coordinated with the manufacturer's as-fabricated drawings such that conduit stub-ups are within the area allotted for conduit.

C. Conduit shall be stubbed up in the section that contains the devices to which conductors are terminated.

3.02 STORAGE AND HANDLING

A. If stored at the Site, motor control centers shall be stored in a clean, dry space.

B. Factory wrapping shall be maintained or an additional heavy plastic cover shall be provided to protect units from dirt, water, construction debris, and traffic.

C. The storage space shall be heated or the MCC space heaters shall be energized.

D. Motor control centers shall be handled carefully to avoid damage to motor control center components, enclosure, and finish.

E. Damage shall be repaired before installation.

3.03 MANUFACTURER'S SERVICES

A. General

1. An authorized Service Representative of the manufacturer shall be present at the Site for 3 Work Days in order to provide the services listed below.
2. For the purpose of this paragraph, a Work Day is defined as an 8-hour period, excluding travel time.
3. The service representative's resume shall be approved by the ENGINEER before training is scheduled.

B. Inspection, Startup, Field Adjustment

1. The Service Representative shall supervise the following items, and shall certify that the equipment and controls have been properly installed, aligned, and readied for operation:
   a. installation of the equipment
   b. inspection, checking, and adjusting of the equipment
   c. startup and field testing for proper operation
   d. performance of repairs to correct any discrepancies or problems revealed during startup and testing
   e. performance of field adjustments to ensure that the equipment installation and operation comply with the indicated requirements
   f. Preparation and submittal of a report covering startup and testing, including a listing of equipment settings and parameters at the end of startup and testing.

3.04 INSTALLATION

A. Motor control centers shall be installed on concrete pads and in accordance with the requirements of Section 16050 – General Electrical Work.

B. After leveling and shimming, the CONTRACTOR shall anchor motor control centers to the concrete pads, and shall grout such that no space exists between the pad and support beams.

C. The CONTRACTOR shall:

1. torque bus bar bolts to manufacturer's recommendations, and tighten sheet metal and structure assembly bolts;
2. adjust motor circuit protector (MCP) devices to the instantaneous trip setting position recommended for the actual horsepower and full load amps of the motor;
3. verify that overload devices are proper for equipment installed;
4. make necessary changes in overload devices as required for motors having power factor correcting capacitors;
5. touch up scratches after the equipment has been installed;
6. verify that nameplate, and other identification is accurate; and
7. provide high-voltage switchboard matting in front of the MCC, in accordance with the requirements of Section 16050 – General Electrical Work.

3.05 FIELD TESTS

A. Provide a visual and mechanical inspection after installation, as follows:

1. Inspect for physical damage, proper anchorage, and grounding.
2. Verify that the ratings of the thermal overload heaters match the motor full-load current nameplate data.
3. Check tightness of bolted connections.

B. Electrical Tests

1. Insulation Tests
   a. Measure the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute.
   b. The test voltage and minimum acceptable resistance shall be in accordance with manufacturer's recommendations.
   c. Measure the insulation resistance of each starter section phase-to-phase and phase-to-ground with the starter contacts closed and the protective device open.
   d. The test voltage and minimum acceptable resistance shall be in accordance with the manufacturer's recommendations.
   e. Measure the insulation resistance of each control circuit with respect to ground.
2. Verify the proper operation of control logic in each mode of control.

END OF SECTION

SECTION 16250
TRANSFER SWITCHES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide electrical service sections, transfer switches, special control panels, circuit breakers, and all appurtenant work, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 16050 – General Electrical Work, apply to the WORK of this Section.

1. Furnish and install the low voltage manual transfer switches having the ratings, features/accessories and enclosures as specified herein and as shown on the contract drawings.

1.02 REGULATORY AGENCIES AND STANDARDS

A. Regulatory Agencies: Installation, materials, equipment and workmanship shall conform to the latest provisions of the following agencies:

1. NEC (NFPA 70) National Electrical Code: 2023 Edition

B. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

C. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 CFR 1926, as applicable), state building standards, and applicable local codes and regulations.

D. Standards: Where referenced in these specifications or on the drawings, the publications and standards of the following organizations apply:

1. ANSI	American National Standards Institute
a. ANSI/IEEE C37.20	Switchgear Assemblies, including Metal-Enclosed Bus
b. ANSI/NEMA ICS-2	Devices, Controllers, and Assemblies for Industrial Control
c. ANSI/UL 1008	Automatic Transfer Switches, Safety Standard for
2. ASTM	American Society of Testing and Materials
3. ICEA	Insulated Cable Engineers Association
4. IEEE	Institute of Electrical and Electronics Engineers
5. NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
6. NFPA	National Fire Protection Association
7. NETA	International Electrical Testing Association

1.03 QUALITY ASSURANCE

A. General: All materials shall be inspected for compliance with Section 16050 – General Electrical Work and shall be tested per Section 16950 - Electrical Tests.

B. Factory Tests: Design test reports conducted on similar assemblies at the factory testing facilities shall be submitted.

1.04 WARRANTY

A. The system warranty shall be no less than one year after initial startup and shall include all costs for repair, parts, travel and living expenses, and labor.

1.05 SUBMITTALS

A. The CONTRACTOR shall submit Shop Drawings of the service section and switchboards in accordance with the requirements for Section 01330 - Submittals.

B. After review by the ENGINEER, the Shop Drawings of the service section shall be submitted to the utility company for approval prior to fabrication.

1.06 FACILITY OPERATION AND MAINTENANCE MANUALS

A. General

1. Submit complete operation and maintenance manual in accordance with the requirements of Section 01680 – Operating and Maintenance Manuals.

B. The CONTRACTOR shall submit operation and maintenance procedures for the ENGINEER's review. The data sheets shall be supplemented by written text and shall include the following:

1. Operating procedures.
2. Maintenance procedures.
3. Manufacturers parts list, illustrations, assemblies, and diagrams.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials: All materials and equipment provided under this Specification shall be new; they shall be in accordance with the requirements of the Institute of Electrical and Electronic Engineers, the National Electrical Manufacturer's Association, the National Fire Protection Association, and the National Electrical Code. Where available, all materials and equipment shall bear the Underwriters' Laboratories label.

B. Equipment: All equipment for the same purpose shall be of the same make.

C. Enclosure Requirements: All outdoor equipment, fixtures, and wiring devices shall be approved, weatherproof construction.

D. Standard Products: Materials and equipment submitted for approval shall be the cataloged products of companies regularly engaged in the manufacture of such items, of the latest standard design that conforms to the specification requirements and shall essentially duplicate material and equipment that has been in satisfactory use for several years.

2.02 AUTOMATIC TRANSFER SWITCH

A. The automatic transfer (ATS) switch shall be a 4-pole, double-throw, with a definite neutral position rated at 480 volts, with the continuous current rating shown.

1. Where a 4-pole switch is indicated on the drawings, the fourth pole shall be used to switch the neutral. The neutral transfer switch shall momentarily interconnect the neutrals of the two sources during the transfer/retransfer operations. The neutrals shall remain interconnected until the power source contacts close on the source to which the load is being transferred. The overlapping neutral contacts shall not be overlapped for a duration greater the 100 milliseconds.

B. The ATS switch shall be able to withstand the short circuit currents indicated or shall have the same withstand rating as the switchboard in which it is installed.

C. The load terminals of the ATS switch shall be de-energized when the ATS switch is in the neutral position; if neutral position is provided the duration of the neutral position shall be adjustable from zero to 30 seconds. The ATS switch shall comply with requirements of ANSI/UL 1008 and ANSI/NEMA ICS-2.

D. The ATS switch shall be manually operable but the manual operating mechanism shall be declutched when the electric operator becomes energized. Mechanical and electrical interlocks shall be provided to prevent simultaneous closure of the normal and emergency positions.

E. The automatic transfer switch shall include integrated controls featuring solid state timing and sensing relays. Protective features and indicators shall include:

1. Three-phase, close-differential undervoltage protection on the Normal source; dropout shall be adjustable from 80-85 percent; pick-up shall be adjustable from 90-95 percent.
2. Engine start and run contact closure; contact closure shall be adjustable from zero to 120 seconds after failure of the Normal source is detected. The engine run contact shall remain closed for an adjustable period of zero to 5 minutes (cool down period) after the load has been transferred back to the normal source.
3. Circuitry shall be provided to prevent transfer to the Emergency source until Emergency source voltage and frequency are within 90 percent of nominal values.
4. Adjustable time delay of retransfer of up to 10 minutes after the voltage of the Normal source has attained the pick-up setting specified in the foregoing Item No. 1 on all phases.
5. The automatic transfer switch shall be equipped with indicator lamps for the Normal and Emergency positions. Two "dry" contacts shall be provided for the Emergency position and one "dry" contact for the Normal position; said contacts shall be wired to identified terminals.
6. Three-position selector switch: TEST-OFF-AUTO; the AUTO position shall cause engine start-up, transfer, and retransfer of the load on failure and subsequent restoration of the Normal source. The TEST position shall simulate failure of the Normal source for however long the switch is in the Test position.

F. The automatic transfer switch shall be manufactured by **ASCO 7000 Series, Russelectric, EATON,** or Approved Equal.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. All electrical equipment shall be installed securely in place. Equipment shall be mounted parallel and perpendicular to the walls, floors, and ceilings.

B. All anchors and fasteners shall be types designed for the intended purpose and shall be capable of adequately, safely, and permanently securing the material in place. Generally, screws shall be used on wood surfaces, masonry anchors in concrete or brick, toggle bolts on hollow walls, machine screws, bolts, or welded studs on steel. Nails shall be used only for temporary attachment or support.

C. Omissions or conflicts on Drawings or between Drawings and Specifications shall be brought to the attention of the ENGINEER for clarification before proceeding with the work.

D. The CONTRACTOR shall make all necessary provisions throughout the Site to receive all equipment as construction progresses and shall provide adequate backing, supports, inserts, and anchor bolts for the hanging and support of all electrical cabinets, enclosures, conduits, panelboards, and switches, and shall provide sleeves through walls, floors, or foundations where electrical lines are required to penetrate.

A. Floor standing equipment shall be leveled with shims as required to maintain horizontal surfaces within 1/32-inch per horizontal foot; after leveling, equipment shall be anchored, then grouted so that no space exists between concrete and equipment support beams.

3.02 PREPARATION AND FINISH SYSTEMS

A. All equipment cabinets or enclosures furnished under this Section shall have a finish that will conform to Section 16155 - Low-Voltage Motor Control Center.

END OF SECTION

SECTION 16431
PROTECTIVE DEVICE STUDIES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Section includes:

1. Short-circuit Fault Analysis Study.
2. Protective Device Coordination Study.
3. Arc-flash Hazard Study.

B. The CONTRACTOR shall perform the indicated short circuit, protective device, and arc flash hazard studies for the electrical power system complete including new, modified, and existing distribution equipment in accordance with the Contract Documents for both the Normal and Emergency Power Systems.

C. The WORK of this Section shall include protection studies for motors with solid state overload and overcurrent protection devices.

D. It is the responsibility of the CONTRACTOR to obtain and collect the information required from the electric utility and appropriate vendors to fully perform the study, including but not limited to engine generator data, motor data, circuit breakers, utility company short circuit, available new and existing device ratings, conductor data, transformer ratings, etc.

1. The CONTRACTOR shall be responsible for scheduling and coordinating the work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the CONTRACTOR'S work.

E. The short circuit portion of the study shall be submitted prior to or along with the switchgear submittal, and shall include all equipment which has an AIC rating. The short circuit study shall reflect that all equipment with an AIC rating is properly rated for its specific application. The submitted switchgear (including all equipment which has and AIC rating) shall reflect the findings of short circuit study (i.e, the AIC ratings of the equipment shall exceed the available short circuit current and any required derating factors at each point in the system). Series ratings are not acceptable.

1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE 141 - Recommended Practice for Electric Power Distribution for Industrial Plants (Red Book).
2. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
3. IEEE 315 - Standards Electrical and Electronics Graphic and Letter Symbols and Reference Designations.
4. IEEE 399 - Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book).
5. IEEE 902 - Guide for Maintenance, Operation and Safety on Industrial and Commercial Power Systems (Yellow Book).
6. IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems - Corrigendum 1 (Blue Book).
7. IEEE 1584 - Guide for Performing Arc Flash Hazard Calculations.

1.03 QUALIFICATIONS

A. CONTRACTOR shall retain a 3rd party independent consultant to perform the study required in this specification.

B. Short circuit studies, protective device evaluation studies, arc-flash hazard analysis studies, and protective device coordination studies shall be performed by a manufacturer who has been regularly engaged in short circuit and protective device coordination services for a period of at least 15 years.

C. The indicated studies shall be signed by the professional electrical engineer, registered in the State of California, responsible for the studies.

D. The studies should utilize computer programs with proven reliability and accuracy for performing 3-phase fault-duty calculations.

1.04 STUDY REQUIREMENTS

A. Report Preparation:

1. Prepare study prior to ordering distribution equipment to verify equipment ratings required.
2. Perform study with aid of computer software program.
3. Calculate short circuit interrupting and, when applicable, momentary duties for assumed 3-phase bolted fault short circuit current and phase to ground fault short circuit current at each of the following:
   a. Utility supply bus.
   b. Medium voltage air interrupter switchgear.
   c. Automatic transfer switch.
   d. Manual transfer switch.
   e. Engine generator.
   f. Medium voltage motor controllers.
   g. Low-voltage switchgear.
   h. Switchboards.
   i. Motor control centers.
   j. Distribution panelboards.
   k. Branch circuit panelboards.
4. Each other significant equipment location throughout system.

B. Report Contents (similar to SKM Power Tools) and include the following:

1. Calculation methods and assumptions.
2. Base per unit value selected.
3. One-line diagram, with short circuit values, arc flash values, feeder values and lengths.
4. Source impedance data including power company system available power and characteristics.
5. Typical calculations.
   a. Fault impedance.
   b. X to R ratios.
   c. Asymmetry factors.
   d. Motor fault contribution.
   e. Short circuit kVA.
   f. Symmetrical and asymmetrical phase-to-phase and phase-to-ground fault currents.
   g. Tabulations of calculation quantities and results.
6. One-line diagram revised by adding actual instantaneous short circuits available.
7. State conclusions and recommendations.

8. Prepare time-current device coordination curves graphically indicating coordination proposed for system, centered on conventional, full-size, log-log forms.
9. Prepare with each time-curve sheet complete title and one-line diagram with legend identifying specific portion of system covered by that particular curve sheet.
10. Prepare detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
11. Plot device characteristic curves at point reflecting maximum symmetrical fault current to which device is exposed. Include on curve sheets the following:
    a. Power company relay characteristics.
    b. Power company fuse characteristics.
    c. Medium voltage equipment protective relay characteristics.
    d. Medium voltage equipment protective fuse characteristics.
    e. Low voltage equipment circuit breaker trip device characteristics.
    f. Low voltage equipment fuse characteristics.
    g. Cable damage point characteristics.
    h. Pertinent transformer characteristics including:
        - Transformer full load current.
        - Transformer magnetizing inrush.
        - ANSI transformer withstand parameters.
        - Significant symmetrical fault current.
    i. Pertinent motor characteristics.
    j. Generator characteristics including:
        - Phase and ground coordination of generator protective devices.
        - Decrement curve and damage curve.
        - Operating characteristic of protective devices.
        - Actual impedance value.
        - Time constants.
        - Current boost data.
        - Do not use typical values for generator.
    k. Transfer switch characteristics.
    l. Other system load protective device characteristics.

1.05 SUBMITTALS

A. The indicated studies shall be submitted and approved by the ENGINEER prior to final approval of the distribution equipment Shop Drawings and release of equipment for manufacture.

B. An initial short circuit study shall be submitted and reviewed before the ENGINEER approves the Shop Drawings for medium-voltage switchgear, transformers, or 480-volt distribution equipment.

C. Submit an initial protective device coordination study shall be submitted within 90 days after the approval of the initial short circuit study.

D. The short circuit, arc-flash hazard analysis, and protective device coordination studies shall be updated prior to Project Substantial Completion; utilize characteristics of as-installed equipment and materials.

E. The adequacy of the equipment "withstand" and interruption ratings shall be approved by the ENGINEER.

F. Submit copies of final report signed by Professional Engineer. Make additions or changes required by review comments.

G. Submit (3) sets all exported software files from approved final report in 32GB thumb drive required.

1. Including the electrical system model(s), configuration files, custom libraries, and any other files used to perform the studies and produce the reports.

2. Software files should be free of password protection to allow OWNER to modify program.

1.06 MANUFACTURERS' SERVICES

A. The low-voltage switchgear manufacturer shall furnish the services of a qualified field engineer and necessary tools and equipment in order to test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the power system coordination study.

B. The motor control center manufacturer shall furnish the services of a qualified field engineer to calibrate the MCPs as recommended in the power system study.

1.07 SEQUENCING

A. The short circuit portion of the study shall be submitted prior to or along with the switchgear submittal, and shall include all equipment which has an AIC rating. The short circuit study shall reflect that all equipment with an AIC rating is properly rated for its specific application. The submitted switchgear (including all equipment which has an AIC rating) shall reflect the findings of short circuit study (i.e., the AIC ratings of the equipment shall exceed the available short circuit current and any required derating factors at each point in the system.). No series rated devices will be allowed.

B. When formal completion of study will cause delay in equipment manufacturing, obtain approval from ENGINEER for preliminary submittal of study data sufficient in scope to ensure selection of device ratings and characteristics will be satisfactory.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. The studies shall include development of single-line and impedance diagrams of the power system.

B. The diagrams shall identify components considered in the study and the ratings of power devices, including transformers, circuit breakers, relays, fuses, busses, and cables.

C. The resistances and reactance’s of cables shall be identified in the impedance diagram.

D. The CONTRACTOR shall obtain the Electric Utility information on the minimum and maximum available fault current, minimum and maximum utility impedances, utility protective device settings including manufacturer and model number, interrupting ratings, X/R ratios, and model information one level above the point of connection:

1. Utility tolerances and voltage variations.

E. The studies shall include every protective device and feeder included within the WORK.

F. The studies shall include all portions of the electrical distribution system for normal and standby power sources down to and including the 480-volt distribution system.

3.02 SHORT CIRCUIT STUDY

A. The short circuit study shall be performed with the aid of a digital computer program, and shall be in accordance with the following Standards:

ANSI/IEEE 141	Recommended Practice for Electrical Power Distribution for Industrial Plants

ANSI/IEEE 242	Recommended Practice for Protection, and Coordination of Industrial, and Commercial Power Systems
ANSI/IEEE C 37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
ANSI/IEEE C 37.13	Low-Voltage AC Power Circuit Breakers Used in Enclosures

3.03 PROTECTIVE DEVICE EVALUATION STUDY

A. A protective device evaluation study shall be performed in order to determine the adequacy of circuit breakers, molded case switches, and fuses.

B. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the attention of the ENGINEER.

C. Do not utilize series-rated circuit breakers to meet short circuit requirements for this project.

D. Devices shall be fully rated to withstand available fault currents.

3.04 PROTECTIVE DEVICE EVALUATION STUDY

A. A protective device coordination study shall be performed in order to develop the necessary calculations to select power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low-voltage breaker trip characteristics and settings.

B. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the ENGINEER's attention.

3.05 TIME/CURRENT COORDINATION CURVES

A. As a minimum, the time/current coordination curves for the power distribution system shall include the following items plotted on 5-cycle log-log graph paper:

1. time/current curves for each protective relay, circuit breaker, or fuse demonstrating graphically that the settings will provide protection and selectivity within industry standards
2. Each curve shall be identified, and tap and time dial settings shall be specified.
3. Provide individual curves for each feeder unless identical to others.
4. Selectivity
    a. Time/current curves for each device shall be positioned to provide the maximum selectivity to minimize system disturbances during fault clearing.
    b. Where selectivity cannot be achieved, the ENGINEER shall be notified as to the cause.
    c. Recommendations shall be included for alternate methods that would improve selectivity.
5. time/current curves and points for cable and equipment damage.
6. circuit interrupting device operating and interrupting times
7. Indicate maximum fault values on the graph.
8. sketch of bus and breaker arrangement
9. magnetizing inrush points of transformers
10. thermal limits of dry-type and liquid-insulated transformers (ANSI damage curve)
11. Every restriction of the ANSI and National Electrical Code shall be followed, and proper coordination intervals and separation of characteristics curves shall be maintained.

3.06 ARC FLASH STUDY

A. An arc flash study shall be performed with the aid of a digital computer program in order to determine the “Arc Flash Protection Boundary” and “Personal Protective Equipment” (PPE)

levels for applicable electrical distribution equipment, stand-alone disconnects, starters, and VFDs in the power distribution system.

B. The arc flash study shall be performed in conjunction with short circuit calculations and protective device coordination.

C. The arc flash study shall be in accordance with the latest version of the following Standards:

1. NFPA 70E Standard for Electrical Safety Requirements for Employee Workplaces
2. IEEE 1584 IEEE guide for performing Arc Flash Hazard Calculations
3. OSHA (29 CFR PART 1910) Occupational Safety and Health Standards for General Industry
4. ANSI Z535.4 Product Safety Signs and Labels

D. The recommended values for the “Arc Flash Protection Boundary” and PPE levels, based on the arc flash study results, shall be tabulated in the study.

E. Labeling

1. The digital computer program shall provide the “Arc Flash Protection Boundary” and PPE values in a format that can be directly printed on to labels.
2. The CONTRACTOR shall provide these labels in accordance with Section 16050 – General Electrical Work.

3.07 FINAL SUMMARY REPORT

A. Summarize the results of the indicated power system studies in a final report.

B. The report shall include the following items:

1. single-line diagram
2. impedance diagram
3. tabulation of all protective devices identified on the single line diagram
4. time/current coordination curves
5. specific recommendations, if any
6. test instrumentation, condition, and connections, as applicable, for each study
7. computerized fault current calculations
8. any suggested changes to the protection scheme or equipment selection that will result in improved system reliability and safety
9. recommendations to minimize the arc flash energy

C. The report shall include information concerning the computer program used for the study, as well as a general discussion of the procedure, items, and data considered in the preparation of the study.

D. Submit 4 bound copies and PDF including all protective device study data files of the report to the ENGINEER.

E. Submit 3 sets all exported software files from approved final report in 32GB thumb drive required.

1. Including the electrical system model(s), configuration files, custom libraries, and any other files used to perform the studies and produce the reports.
2. Software files shall be free of password protection to allow OWNER to modify program.

3.08 PROTECTIVE DEVICE TESTING, CALIBRATION, AND ADJUSTMENT

A. Test, calibrate, and adjust the protective relays and circuit breaker trip devices in accordance with the recommendations in the power system coordination study.

B. Calibrate the MCPs as in accordance with the recommendations in the power system study.

C. Adjustments shall be made prior to energizing any electrical equipment.

D. Provide the services of a qualified testing agency and the necessary tools and equipment to test, calibrate and adjust the protective relays and circuit breaker trip devices as recommended in the settings table provided by the coordination study. Field adjustments to be completed by the CONCTRACTOR.

3.09 ARC-FLASH HAZARD TRAINING

A. Provide training for a minimum of 6 personnel at the project site on the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours excluding travel time).

B. The training shall be held at the OWNERs facility:

1. Provide a minimum of 3-weeks' notice to the Owner and Engineer in advance of the projected meeting date.
2. Submit a draft of the meeting agenda when each meeting is requested.

C. Meeting materials:

1. Prepare and provide the following materials:
   a. Meeting agenda. Include, at a minimum, the scope of the meeting, estimated time length for the meeting, and meeting goals.
   b. 6 copies of the project one-line diagrams for the initial meeting.
   c. 6 copies of the submitted studies.

D. Maintenance procedures in accordance with the requirements of NFPA 70E shall be provided in the training manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

END OF SECTION

SECTION 16450
GROUNDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide the electrical grounding system, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 16050 – General Electrical Work, apply to this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.02 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals and Section 16050 – General Electrical Work.

B. Shop Drawings

1. Submit manufacturer's product information for connectors, clamps, and all grounding system components, showing compliance with the requirements of this Section.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. Components of the grounding electrode system shall be manufactured in accordance with UL 467 - Standard for Safety Grounding and Bonding Equipment and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes.

B. Grounding System

1. Grounding loop conductors shall be bare annealed tin-plated copper conductors.
2. Conductors shall be No. 4/0 unless indicated otherwise.
3. Ground Rods
   a. Unless indicated otherwise, provide ground rods minimum of 3/4 inch in diameter, 10 feet long, and with a uniform covering of electrolytic copper metallically bonded to a rigid steel core.
   b. Provide corrosion-resistant copper-to-steel bond.
   c. The rods shall conform to UL 467.
   d. The rods shall be of the sectional type, joined by threaded copper alloy couplings.
4. Buried, concrete-encased, or otherwise inaccessible cable-to-cable and cable-to-ground rod connections using exothermic welds.
   a. Manufacturer, or Equal
      - **Cadweld**
      - **Thermoweld**
5. Exposed Connectors
   a. Exposed grounding connectors shall be of the compression type (connector-to-cable), constructed of high-copper alloy, and manufactured specifically for the particular grounding application.
   b. Manufacturer, or Equal

- **Burndy**
- **O.Z. Gedney**

6. Use grounding clamps to bond each separately-derived system to the grounding electrode conductors.
7. Equipment Grounding Circuit Conductors
   a. The conductors shall be the same type and insulation as the load circuit conductors.
   b. The minimum size shall be as indicated. Where not indicated, sizes shall conform to Table 250.122 of the National Electrical Code.
   c. Metallic conduit systems shall have an equipment grounding wires as well as being equipment grounding conductors themselves.
8. Grounding Materials Manufacturer, or Equal
   a. **Copperweld**
   b. **Thermoweld**
   c. **OZ Gedney**

PART 3 - EXECUTION

3.01 PREPARATION

A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.

B. Provide a separate grounding conductor for each motor and connect at motor box. Provide a supplemental ground connection for motor shaft grounding rings, where applicable.

C. Do not use bolts for securing the motor box to the frame or the cover for grounding connectors.

D. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.

E. Route the conductors inside the raceway.

F. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each MCC section, switchboard, or panelboard.

G. Individually bond the raceway to the ground bus in the secondary section.

H. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.

I. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.

J. Interconnect the secondary switchgear MCC or panelboard neutral bus to the ground bus in the secondary switchgear compartment only at the service entrance point. For wye connected, 3 phase, separately derived systems with 3 wire distribution, connect the transformer neutral to the grounding electrode system at the transformer. Connections shall be in accordance with the NEC.

K. Provide the duct bank ground system as indicated, including trenching, splices, ground rods, and connections to equipment and structures.

L. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system. Provide additional grounding system testing in accordance with Section 16950 – Electrical Tests.

M. Low Voltage Grounded System (600V or less)

1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.

2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.
3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.

N. Embedded Ground Connections
1. Underground and grounding connections embedded in concrete shall be UL-listed ground grid connectors.
2. The connection shall be made in accordance with the manufacturer's instructions.
3. Do not conceal or cover ground connections until the ENGINEER or an authorized representative has established that every grounding connection conforms to the requirements of the Contract Documents and has given the CONTRACTOR written confirmation.

O. Ground Ring
1. Furnish trenching and materials as necessary to install the ground ring as indicated.
2. The bonding conductor shall be in direct contact with the earth and of the indicated size.
3. Provide a minimum burial depth of 36 inches or as indicated on the Drawings, whichever is greater.
4. Re-compact disturbed soils to their original density in 6-inch lifts.

P. Duct Bank Ground
1. Embed a grounding conductor in every duct bank as indicated. The ground conductor shall be terminated at the ground grid at each end of the duct bank. Where no ground grid is installed, terminate at a suitable grounding electrode conductor near the end of the duct bank in accordance with the NEC.

Q. Ground Rods
1. Provide ground rods at the indicated locations.
2. A single electrode that does not have resistance-to-ground of 5 ohms or less shall be augmented by additional electrodes to obtain this value.
3. Take the resistance-to-ground measurement during dry weather, a minimum of 48 hours after a rainfall.
4. Rods forming an individual ground array shall be equal in length.

R. Instrumentation Shield Grounding
1. Shielded instrumentation cable shall have its shield grounded at one end only unless the approved Shop Drawings indicate that the shield will be grounded at both ends.
2. The grounding point shall be at the control panel or at the receiving end of the signal carried by the cable.
3. The termination of the shield drain wire shall be on its own terminal screw.
4. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.
5. Connect the ground bus via a green No. 12 conductor to the main ground bus for the panel.

END OF SECTION

SECTION 16460
LOW VOLTAGE TRANSFORMERS AND SWITCHGEAR

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide electrical service sections, distribution switchboards, special control panels, control and terminal cabinets, control devices, circuit breakers, and all appurtenant work, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 16050 – General Electrical Work, apply to the WORK of this Section.

1.02 REGULATORY AGENCIES AND STANDARDS

A. Regulatory Agencies: Installation, materials, equipment and workmanship shall conform to the latest provisions of the following agencies:

1. NEC (NFPA 70) National Electrical Code: 2020 Edition

B. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

C. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 CFR 1926, as applicable), state building standards, and applicable local codes and regulations.

D. Standards: Where referenced in these specifications or on the drawings, the publications and standards of the following organizations apply:

1. ANSI	American National Standards Institute
a. ANSI/IEEE C37.20	Switchgear Assemblies, including Metal-Enclosed Bus
b. ANSI/NEMA ICS-2	Devices, Controllers, and Assemblies for Industrial Control
c. ANSI/UL 1008	Automatic Transfer Switches, Safety Standard for
2. ASTM	American Society of Testing and Materials
3. ICEA	Insulated Cable Engineers Association
4. IEEE	Institute of Electrical and Electronics Engineers
5. NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
6. NFPA	National Fire Protection Association
7. NETA	International Electrical Testing Association

1.03 QUALITY ASSURANCE

A. General: All materials shall be inspected for compliance with Section 16050 – General Electrical Work, and shall be tested per Section 16950 - Electrical Tests.

B. Factory Tests: Design test reports conducted on similar assemblies at the factory testing facilities shall be submitted.

1.04 WARRANTY

A. The system warranty shall be no less than one year after initial startup and shall include all costs for repair, parts, travel and living expenses, and labor.

1.05 SUBMITTALS

A. The CONTRACTOR shall submit Shop Drawings of the service section and switchboards in accordance with the requirements for Section 01330 - Submittals.

B. After review by the ENGINEER, the Shop Drawings of the service section shall be submitted to the utility company for approval prior to fabrication.

1.06 FACILITY OPERATION AND MAINTENANCE MANUALS

A. General

1. Submit complete operation and maintenance manual in accordance with the requirements of Section 01680 – Facility Operation and Maintenance Manuals.

B. The CONTRACTOR shall submit operation and maintenance procedures for the ENGINEER's review. The data sheets shall be supplemented by written text and shall include the following:

1. Operating procedures.
2. Maintenance procedures.
3. Manufacturers parts list, illustrations, assemblies, and diagrams.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials: All materials and equipment provided under this Specification shall be new; they shall be in accordance with the requirements of the Institute of Electrical and Electronic Engineers, the National Electrical Manufacturer's Association, the National Fire Protection Association, and the National Electrical Code. Where available, all materials and equipment shall bear the Underwriters' Laboratories label.

B. Equipment: All equipment for the same purpose shall be of the same make.

C. Enclosure Requirements: All outdoor equipment, fixtures, and wiring devices shall be of approved, weatherproof construction.

D. Standard Products: Materials and equipment submitted for approval shall be the cataloged products of companies regularly engaged in the manufacture of such items, of the latest standard design that conforms to the specification requirements, and shall essentially duplicate material and equipment that has been in satisfactory use for several years.

2.02 SWITCHBOARD

A. Indoor construction shall be of the universal frame type using die-formed welded and bolted members. Enclosing panels shall be 14-gauge steel, bolted in place. In addition, indoor construction shall conform to the following:

1. Switchboard shall be totally enclosed, NEMA 3R, gasketed.
2. Bus bar shall be copper fully insulated. Copper shall be silver plated at joints. Bus bars shall be braced for short circuits of 65,000 amperes RMS symmetrical minimum, or as indicated on the Drawings. A full-length copper ground bus bar shall be provided at the bottom of the switchboard enclosure.
3. Main Beakers and bus rating shall be 100 percent rated.

B. Outdoor construction shall be as described in the previous paragraph, except that switchboard installation shall be rodent- and bird-proof. Outdoor switchgear construction shall be NEMA 3R, non-walk-in type. An insulating compound shall be applied to the interior surface of roof panels for condensation control.

C. Floor-standing distribution switchboards, and main service switchboard, shall be cataloged products of the main circuit breaker manufacturer. Switchboard shall be shipped fully assembled and tested.

2.03 MAIN SERVICE SWITCHBOARD

A. General: The main service switchboard shall consist of a freestanding assembly that complies with the Contract Documents, with particular reference to the provisions of the above paragraph entitled, "Switchboard."

B. The system operating voltage and number of wires shall be as indicated.

1. Power

a. The MSB shall receive power from a 3-phase, wye-connected 277/480-volt PG&E service transformer with a grounded neutral.

b. Power distribution from the MSB shall be 277/480-volt, 3-phase, 4-wire.

c. The MSB Bus Rating shall not exceed 400A to comply with PG&E pole mounted utility transformer requirements.

C. Switchboard: Switchboards shall be front-accessible. Switchboards shall be constructed to accommodate additional distribution sections. The switchboards shall consist of the sections described in the following paragraphs.

D. Service Section: The service section shall consist of an underground pull compartment and a revenue metering compartment all to utility requirements. Components such as meter bases, busses, lugs, and auxiliaries shall be furnished.

E. Main Circuit Breaker Compartment: The main circuit breaker compartment's circuit breaker unit shall have the ratings indicated. Service neutral shall be brought to a terminal in the main circuit breaker compartment. A disconnecting link shall be provided in a bus bar connection between the neutral terminal and the switchboard ground bus.

1. The circuit breaker shall have protective features with capability of selective tripping which can be used to provide overcurrent protection from overloads, short circuits, and ground faults.

2. Main Beakers and bus rating shall be 100 percent rated.

F. The circuit breaker shall be individually mounted stationary of the size and type indicated. Manual charging shall be provided where indicated.

G. Distribution Section: The distribution section shall consist of stationary molded case circuit breakers of the size indicated. A full-length vertical bus shall be provided for each distribution section. The rating shall be 300 amperes, or more where indicated.

H. Switchboards shall comply with NEMA, UL and ANSI standards for industrial control. Provide 277/480VAC 3PH 4W 400A SQUARE-D, EATON or approved equivalent.

1. 600A Rated Main Switchboards will not be accepted.

2.04 OVERCURRENT PROTECTIVE DEVICES

A. Circuit breakers having a frame size of 150 amperes or less shall be molded-case type with thermal, magnetic, non-interchangeable, trip-free, sealed trip units. The breaker contact material shall be a non-weldable silver alloy. The breakers shall have arc-extinguishing chutes. Ground fault tripping, where required, shall be as required below.

B. Circuit breakers with a frame size of 225 amperes to 600 amperes shall be molded case with interchangeable thermal and adjustable magnetic trip elements. Ground fault protection shall be provided by means of a core balance transformer encircling all feeder leads. The transformer shall energize a surface-mounted, solid-state relay, adjustable from 10 - 20 percent of phase current with an adjustable time delay of zero to 36 cycles. Ground fault protection shall include a test panel containing indication and test tripping circuits.

C. Circuit breakers with a frame size more than 600 amperes shall be molded case as described above, except if power circuit breakers are indicated. Molded case circuit breakers shall have an integral, solid state over-current trip unit and line current sensors.

1. Trip units shall have adjustable long-time tripping in the range of 60 to 100 percent of continuous rating, instantaneous tripping adjustable in the range of 300 to 1000 percent of continuous rating, and ground fault tripping adjustable in the range of 20 to 60 percent of continuous rating, with adjustable delay of approximately 5 to 40 cycles.

D. Power circuit breakers shall be of the stationary type. The power circuit breakers shall be insulated case units. The draw-out mechanism shall have four positions: connected, test, disconnect, and remove. The circuit breaker element shall be able to assume the connected, test, and disconnected positions with the circuit breaker cubicle door closed.

E. Interlocks shall be provided to assure that the circuit breaker element is open before movement from a position is possible; stored energy mechanism shall be discharged automatically upon removal of the circuit breaker element from its cubicle. Charging of stored energy springs shall be manual; closing of the main power contacts shall automatically charge the tripping springs. A manual trip button, position indicators, and status of stored energy mechanism shall be fitted to the front panel.

F. Power circuit breakers shall be equipped with an integral solid-state 3 phase tripping unit as described above.

G. Circuit breaker interlocking shall include an anti-pumping circuit.

H. The power circuit breakers shall be **Square D, EATON, or Approved Equal.**

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. All electrical equipment shall be installed securely in place. Equipment shall be mounted parallel and perpendicular to the walls, floors, and ceilings.

B. All anchors and fasteners shall be types designed for the intended purpose and shall be capable of adequately, safely, and permanently securing the material in place. Generally, screws shall be used on wood surfaces, masonry anchors in concrete or brick, toggle bolts on hollow walls, machine screws, bolts, or welded studs on steel. Nails shall be used only for temporary attachment or support.

C. Omissions or conflicts on Drawings or between Drawings and Specifications shall be brought to the attention of the ENGINEER for clarification before proceeding with the work.

D. The CONTRACTOR shall make all necessary provisions throughout the Site to receive all equipment as construction progresses and shall provide adequate backing, supports, inserts, and anchor bolts for the hanging and support of all electrical cabinets, enclosures, conduits, panelboards, and switches, and shall provide sleeves through walls, floors, or foundations where electrical lines are required to penetrate.

A. Floor standing equipment shall be leveled with shims as required to maintain horizontal surfaces within 1/32-inch per horizontal foot; after leveling, equipment shall be anchored, then grouted so that no space exists between concrete and equipment support beams.

3.02 PREPARATION AND FINISH SYSTEMS

A. All equipment cabinets or enclosures furnished under this Section shall have a finish that will conform to Section 16155 - Low-Voltage Motor Control Center.

END OF SECTION

SECTION 16470

PANELBOARDS AND GENERAL-PURPOSE DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide panelboards and general-purpose dry-type transformers, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer: Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.02 SUBMITTALS

A. General: Submittals shall be in accordance with Section 01300 - Submittals and Section 16050 – General Electrical Work.

B. Shop Drawings

1. Transformers
    a. Dimension drawings
    b. Technical certification sheets
    c. Drawing of conduit entry/exit locations
    d. Transformer ratings, including:
        - Voltage
        - Continuous current
        - Basic impulse level for equipment over 600 volts
        - KVA
    e. Descriptive bulletins
    f. Product sheets
2. Panelboards
    a. Breaker layout drawings with dimensions and nameplate designations
    b. Component list
    c. Drawings of conduit entry/exit locations
    d. Assembly ratings including:
        - Short circuit rating
        - Voltage
        - Continuous current
    e. Cable terminal sizes
    f. Descriptive bulletins
    g. Product sheets
    h. Installation information
    i. Seismic certification and equipment anchorage details

PART 2 - PRODUCTS

2.01 GENERAL

A. Transformers

1. The transformers shall be dry-type, designed, manufactured, and tested in accordance with the latest applicable standards of ANSI and NEMA.
2. Transformers shall be UL-listed and bear the UL label.

B. Panelboards

1. Panelboards shall be dead front factory assembled. Panelboards shall comply with NEMA PB-1-Panelboards, as well as the provisions of UL 50 - Safety Enclosures for Electrical Equipment and UL 67 - Safety Panelboards. Panelboards used for service equipment shall be UL labeled for such use. Lighting panelboards shall be rated for 120/208-volt, 3 phase operation or 120/240 volt for single phase operation as indicated. Power panelboards shall be rated for 480 volts, 3 phase, 3 wire operation, unless indicated otherwise.
2. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.

2.02 TRANSFORMERS

A. Energy Efficiency: Standard dry-type transformers shall meet the energy efficiency requirements of the Department of Energy Code of Federal Regulations (10 CFR PART 431), DOE 2016 Efficiency Levels. The product requirements are in the appliance regulations, Title 20, and the usage requirements are in Title 24.

B. Ratings

1. KVA and voltage ratings shall be as indicated.
2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96 - Guide for Loading Dry Type Distribution and Power Transformers
3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

Up to 9 kVA	40 dB
10 to 50 kVA	45 dB
51 to 150 kVA	50 dB

C. Construction

1. Insulation Systems
   a. Transformers shall be insulated as follows:
      - 2 kVA and smaller: 150 deg C insulation system based upon 80 deg C rise.
      - 3 to 15 kVA: 185 deg C insulation system based upon 115 deg C rise.
      - 15 kVA and larger: 220 deg C insulation system based upon 150 deg C rise.
   b. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 deg C maximum ambient.
   c. Insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM D 635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
2. Transformer windings shall be copper.
3. Transformers shall have four 2-1/2 percent taps, 2 above and 2 below 480 volts.
4. Transformer shall include vibration dampeners between the core and the enclosure to minimize and isolate sound transmission.

D. Manufacturers: **General Electric, Eaton, Schneider Electric/Square D Company, or equal**.

2.03 PANELBOARDS

A. Ratings

1. Panelboards rated 240-VAC or less shall have short circuit ratings not less than 22,000 amperes RMS symmetrical.
2. Panelboards rated 480-VAC shall have short circuit ratings not less than 65,000 amperes RMS symmetrical or as indicated by the Protective Device Study, whichever is greater.
3. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

B. Construction

1. Lighting and power distribution panels shall have tin-plated copper bus bars.
2. Breakers shall be one, 2, or 3-pole as indicated, with ampere trip ratings as required by the equipment. Breakers shall be quick-make and quick-break, inverse time trip characteristics, to trip free on overload or short circuit, and to indicate trip condition by the handle position.
3. The panels shall have hinged doors with combination catch and latch. The front panels shall be so arranged that when the plates are removed, the gutters, terminals and wiring will be exposed and accessible. The doors shall have inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.
4. Panelboards shall be rated for the intended voltage.
5. Circuit breakers shall be interchangeable and capable of being operated in any position as well as being removable from the front of the panelboard without disturbing adjacent units. No plug-in circuit breakers will be acceptable.
6. Lighting and power distribution panels which are not part of a motor control center shall be constructed in accordance with Section 16050 – General Electrical Work, Panels shall have the necessary barriers, supports, and liberal wiring gutters. Trim screws shall be stainless steel. Panelboard parts of metal other than copper, aluminum, or stainless steel shall be cadmium plated.
7. Panelboards shall be UL listed except for special enclosures which are not available with UL listing.
8. Panelboards shall be suitable for use as service entrance where indicated.

C. Manufacturers: **General Electric, Eaton, Schneider Electric/Square D Company, or equal**

D. Surge Protection Devices (SPD)

1. Provide integral SPDs. SPDs shall conform to Section 16671 – Surge Protection Devices.
2. SPD units shall be rated for the voltage and phase service of the panel at 120 k per phase.

2.04 NAMEPLATES

A. Nameplates shall meet the requirements of Section 16050 – General Electrical Work.

PART 3 - EXECUTION

3.01 GENERAL

A. The work of this Section shall be installed as indicated in Section 16050 – Electrical Work, General.

END OF SECTION

SECTION 16473
ELECTRICAL UTILITY SERVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide and coordinate the electrical utility WORK, complete and operable, as indicated in accordance with the Contract Documents.

B. Coordination with the utility companies to provide service.

C. Contractor's responsibilities for connecting to utilities and providing utility service to the facilities.

D. The CM and Engineer shall be copied on all correspondence with PG&E.

E. Related Specification Sections include but are not necessarily limited to:

1. Section 16050 – General Electrical Work
2. Section 16450 – Grounding
3. Section 16110 – Electrical Raceways Systems
4. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any Contractor's Work.

1.02 SYSTEM DESCRIPTION

A. Service overview:

1. Under this project, a new utility service is required to provide a 400A service to the Will S. Green Pump Station MSB-10. The contractor shall install a new 277/480VAC Main Switchboard located outside as shown on CONTRACT DRAWINGS.
   a. The contractor shall install primary/secondary conduits and risers per PG&E-engineering drawings, Contract Documents, and PG&E Green Book as required to service the new main switchboard.
   b. The contractor shall install precast transformer pad and all associated grounding required for PG&E provided pad mounted transformer.
   c. The contractor shall install secondary conduits and risers per PG&E-engineering drawings, Contract Documents, and PG&E Green Book as required for service.

B. Electrical service:

1. Provide all Work and materials for the permanent electrical service.
2. All fees and costs associated with the permanent electric service will be paid by the OWNER.
3. Provide electrical ducts, raceways, conductors, and connections indicated on the Drawings, and all other Work and materials required for a complete electrical service including but not limited to:
   a. Construction of the primary/secondary trench from the PG&E Pole to the new Main Switchboard.
   b. Installation of new conduits in the service trench.
   c. Backfill of the service trench and concrete cap (if required by PG&E).
   d. PG&E will provide and terminate the primary/secondary service conductors.
   e. Coordination with PG&E for all inspection activities.
   f. Submittal of the drawings and cutsheets to PG&E for review and approval.
   g. Coordinating downstream facility shutdown with PG&E and 30-days prior to trenching existing system for the new service.

C. General:

1. Coordinate and obtain inspections and final installation approval from the serving utilities and other authorities having jurisdiction.
2. Coordinate installation of the service transformer and metering with the serving utility.
    a. The serving utility for this Project is PG&E.
    b. Provide primary/secondary conduits, riser, space in the switchboard for mounting of metering CT's, and CT compartment to the meter socket.
    c. Primary/Secondary conduit sized as required by utility.
    d. The utility will furnish the transformer, primary/secondary service wire, metering CT's to be mounted in the switchboard, meter and meter socket, and make all connections at the transformer, CT's and meter socket.
    e. Coordinate the switchboard supplier and the utility for the CT compartment and EUSERC approved compliance.

1.03 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals and Section 16050 – General Electrical Work.

B. Shop Drawings

1. Submit manufacturer's product information for connectors, clamps, and all grounding system components, showing compliance with the requirements of this Section.

1.04 SCHEDULING

A. General:

1. Before the start of Site Work, make arrangements for temporary telephone and electrical service as required.

B. Electrical systems:

1. The electrical contractor shall contact the utilities to determine the Work and materials that will be required from the Contractor, and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the bid.
2. Coordinate Work with Engineer to minimize downtime of existing operating equipment and electrical distribution systems and to preclude unsafe operation:
    a. Notify OWNER 30 days before power interruptions.
    b. Coordinate downtime with District and local electric utility.
3. Before commencing Work, coordinate electric service entrance requirements with local electric utility to ensure that the installation will be complete as specified in these Contract Documents:
    a. Ensure power transformer size, electrical characteristics, and location are consistent with the design and service voltage provided by the electric utility coordinated with other trades.
    b. Arrange for utility revenue meter.
    c. Coordinate installation of metering CTs and PTs furnished by the electric utility.
4. During the construction of the Project, the existing electrical service must remain fully functional to supply uninterrupted electrical power to the facility and its ancillary buildings and structures.
    a. Interruption is permitted for the changeover of the PG&E service to the new switchgear.

C. Before commencing Site Work, coordinate underground conduit installations with other work.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 INSTALLATION

A. As specified in Section 16050 – General Electrical Work.

B. All installations shall comply with PG&E installation standards and Green Book.

3.02 FIELD QUALITY CONTROL

A. As specified in Section 16050 – General Electrical Work.

3.03 CLEANING

A. As specified in Section 16050 – General Electrical Work.

END OF SECTION

SECTION 16485
INDUSTRIAL CONTROL PANELS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide complete industrial control panels and/or local control stations as indicated herein or in other Sections of the Specifications. The stations shall be designed to provide the sequence of operation in Section 17100 – Process Control and Instrumentation Systems and the P&ID Drawings.

B. This section also specifies miscellaneous electrical devices used throughout this project. These devices are not limited to use within industrial control panels or local control stations.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Industrial control panels and/or local control stations shall comply with the requirements of NEC (including Article 409), NEMA, and UL.

1.03 SUBMITTALS

A. Furnish Shop Drawings in accordance with Sections 01300 – Submittals and 16050 – General Electrical Work.

1. Ladder diagrams and written descriptions explaining ladder diagram operation and system operation.
2. Include catalog cuts of control equipment including enclosures, overcurrent devices, relays, pilot devices, terminations, and wire troughs.

PART 2 - PRODUCTS

2.01 GENERAL

A. The CONTRACTOR shall provide the equipment, panels and stations to satisfy the functional requirements in the relevant mechanical equipment and Instrumentation and Control specifications and the Electrical Elementary Schematics. Each panel and station shall be fabricated with UL labeled components. Equipment not specifically indicated as being WORK of other Sections shall be provided under this Section. All equipment, panels and stations shall be wired under this Section.

B. The controls shall be 120 V maximum. Where the electrical power supply is 240 V, single phase or 480 V, 3 phase, the station shall be provided with a fused control power transformer. Control conductors shall be provided in accordance with Section 16120 – Wire and Cabling.

C. Each panel and/or station shall be provided with identified terminal strips for the connection of external conductors. The CONTRACTOR shall provide sufficient terminal blocks to connect 25 percent additional conductors for future use. Termination points shall be identified in accordance with Shop Drawings. The panels and/or stations shall be the source of power for all 120 VAC solenoid valves interconnected with the panels and/or stations. Equipment associated with the panels and/or stations shall be ready for service after connection of conductors to equipment, controls, panels and/or stations.

D. Wiring to door-mounted devices shall be extra flexible and anchored to doors using wire anchors cemented in place. Exposed terminals of door-mounted devices shall be guarded to prevent accidental personnel contact with energized terminals.

E. Enclosures

1. In finished rooms, enclosures shall be NEMA 12 steel enclosures painted with ANSI 61 exterior and white interior.
2. In all other non-hazardous areas, enclosures shall be NEMA 4X stainless steel with brushed finish. Where possible, penetrations shall be made in such a manner to maintain the

NEMA 4X rating. If this is not possible, the penetrations shall be made in such a manner to minimize entry of foreign materials into the enclosure, subject to approval by the ENGINEER.

3. In hazardous areas, enclosures shall be cast aluminum NEMA 7 and shall be UL listed for use in hazardous or classified locations.
4. In chemical areas for alum, sodium hypochlorite, etc., NEMA 4X fiberglass enclosures shall be used.
5. Enclosures shall be freestanding, pedestal-mounted, or equipment skid-mounted, as indicated. Internal control components shall be mounted on a removable mounting pan. Mounting pan shall be finished white.
6. Outdoor mounted enclosures shall be provided with thermostatically-controlled heaters. Heaters shall be operated at ½ rated voltage (240 volt heaters shall be sized and operated at 120 volts).

F. Disconnect Switches

1. Heavy duty,fusible or non-fusible, single throw switches shall be rated not less than 65 KAIC at 480 VAC.
2. Horsepower rated
3. UL listed
4. Padlockable in "Off" position and door interlock
5. Enclosure per area classification in Section 16050 – General Electrical Work.
6. 480 V, 3-phase, 3-pole (6-pole when used with 2-speed motor).
7. Auxiliary control contact as applicable and where indicated.
8. As manufactured by **GE, Eaton Electrical, Square D,** or equal.

G. Identification of panel-mounted devices, conductors, and electrical components shall be in accordance with Section 16050 – General Electrical Work.

H. Panel-mounted devices shall be mounted a minimum of 3-feet above finished floor elevation, but not higher than 6’-6” above finished floor, unless noted otherwise.

2.02 PANEL/STATION COMPONENTS

A. Pushbuttons, selector switches, and pilot lights shall be the heavy-duty, oil-tight type, sized to 30-mm. Miniature style devices are not acceptable. Devices shall be as manufactured by **Allen Bradley, EATON, Square-D,** or equal.

1. Lens colors shall be GREEN for "run," "open," or "on"; RED for "stopped," "closed," or "off"; and AMBER for alarm.
2. Pilot lights shall be full voltage, push-to-test LED cluster type.
3. Provide hazardous location type pilot devices in classified locations.

B. Relays shall be 3 PDT with 10 amp contacts, plug-in type with indicating light, rectangular blades and provided with sockets for screw-type termination and hold-down clips. Relays shall be as manufactured by **Square-D, Potter Brumfield,** or equal.

C. Elapsed time meters shall be non-resettable type, read to a maximum of 99999.9 hours and shall be as manufactured by **GE, EATON,** or equal.

D. Magnetic starters shall be:

1. NEMA rated, Size 1 minimum. IEC or dual NEMA/IEC rated type are not acceptable.
2. FVNR type unless indicated otherwise.
3. Combination starters with magnetic only instantaneous trip circuit breakers such as **EATON HMCP, SE GV5PB,** or equal. Breakers shall be rated 65 KIAC minimum.

4. Control transformers shall be provided with primary and secondary fuses, 120 V maximum control voltage. VA rating of transformer shall be based on devices on the control schematic.

E. Terminal strips shall be provided for every panel and shall be the flanged fork or ring lug type suitable for No. 12 AWG stranded wire minimum. Provide 25 percent spare terminals in each panel.

F. Time delay relays shall be combination on delay and off delay (selectable) with adjustable timing ranges. Provide socket with screw terminal connections and retaining strap. Time delay relays shall be **Square D, ATC, EATON,** or equal.

2.03 FACTORY TESTING

A. Each panel/station shall be factory assembled and tested for sequence of operation prior to delivery.

2.04 SPARE PARTS

A. Provide a minimum of 10 percent spare lamps (minimum 2) and one spare lens for each color pilot lamp in each panel.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Panels/stations shall be installed in accordance with in Section 16050 – General Electrical Work, and in accordance with the manufacturer's recommendations.

B. Panels/stations shall be protected at the site from loss, damage, and the effects of weather. Panels/stations shall be stored in an indoor, dry location. Heating shall be provided in areas subject to corrosion and humidity.

C. Panels/station interiors and exteriors shall be cleaned, and coatings shall be touched up to match original finish upon completion of the WORK.

D. Conduit, conductors, and terminations shall be installed in accordance with Section 16050 – General Electrical Work.

3.02 FIELD TESTING

A. Each panel/station shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.

END OF SECTION

SECTION 16500
LIGHTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide luminaires, lighting controls, wiring devices, accessories, complete and operable, in accordance with the Contract Documents.

1. This section includes requirements for furnishing, installing, programming, and commissioning a complete lighting control system including relay panels, distributed relay packs, sensors, photocells, time clocks, dimming interfaces, and all associated low-voltage control wiring.

B. The requirements of Section 16050 – General Electrical Work, apply to this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.02 REGULATORY AGENCIES AND STANDARDS

A. Regulatory Agencies: Installation, materials, equipment and workmanship shall conform to the latest provisions of the following agencies:

1. CBC	California Building Code
2. CEC (TITLE 20)	California Energy Commission
3. CEC (TITLE 24)	California Electrical Code
4. IBC	International Building Code - Earthquake Requirements
5. NEC (NFPA 70)	National Electrical Code: 2023 Edition
6. OSHA	Occupational Safety and Health Act
7. UBC	Uniform Building Code

B. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

C. Standards: Where referenced in these specifications or on the drawings, the publications and standards of the following organizations apply:

1. AEIC	Association of Edison Illuminating Companies
2. ANSI	American National Standards Institute
3. ANSI C82.1 – Specifications for Fluorescent Lamp Ballasts	
4. ANSI C84.4 – Specifications for High-Intensity-Discharge Lamp Ballasts (Multiple Supply)	
5. ASTM	American Society of Testing and Materials
6. ICEA	Insulated Cable Engineers Association
7. IEEE	Institute of Electrical and Electronics Engineers
8. NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
9. NFPA	National Fire Protection Association
10. NETA	International Electrical Testing Association

D. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

1. UL-595	Standard for Safety Marine-Type Electric Lighting Fixtures

2. UL-844 Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified Locations)

3. UL-924 Standard for Safety Emergency Lighting and Power Equipment

Standards of the Certified Ballast Manufacturer's Association

1.03 SUBMITTALS

A. Furnish the following product information in accordance with the requirements of Section 01300 – Submittals.

B. Shop Drawings: Include the following information:

1. Equipment Information
    a. name of drive manufacturer
    b. type and model
    c. assembly drawing and nomenclature
2. Building layout with fixture and device locations
3. Lighting fixture and control wiring schematics
4. Light control panel circuits and relay output diagrams
5. Lighting fixture sensors
6. Lighting switch and dimming sensor locations
7. Network topology
8. Device Diagram
    a. Submit the system schematic interconnection diagrams.
    b. The schematic ladder diagram shall include remote devices.
    c. The ladder diagram shall incorporate the control logic on the corresponding elementary schematic as indicated.
    d. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED."

C. Furnish the following information:

1. Interior Luminaires
    a. catalog data sheets and photos
    b. luminaire finish and metal gauge
    c. lens material, pattern, and thickness
        - candlepower distribution curves in 2 or more planes
    d. candlepower chart, 0 to 90 degrees
    e. lumen output chart
    f. average maximum brightness data in foot-lamberts
    g. coefficients of utilization for zonal cavity calculations
    h. mounting or suspension details
    i. heat exchange and air handling data
2. Exterior Luminaires
    a. catalog data sheets and photos
    b. luminaire finish and metal gauge
    c. lens material, pattern, and thickness

d. IES lighting classification and isolux diagram

e. fastening details to wall or pole

f. ballast type, location, and method of fastening

g. for light poles: wind loading; complete dimensions; and finish

3. Lamps

a. voltages

b. colors

c. approximate life (in hours)

d. approximate initial lumens

e. lumen maintenance curve

f. lamp type and base

4. LED Drivers

a. type

b. wiring diagram

c. nominal watts and input watts

d. input voltage and power factor

e. starting current, line current, and restrike current values

f. sound rating

g. temperature rating

h. efficiency ratings

i. low-temperature characteristics

j. emergency ballasts rating and capacity data

5. Lighting Controls

a. voltage and power consumption

b. capacity

c. contacts and time delay

d. operating levels

e. enclosure type and dimensions

f. temperature range

D. Closeout Submittals

1. As-built drawings

2. Commissioning Reports

1.04 QUALITY ASSURANCE

A. A. Manufacturer shall have minimum 10 years' experience producing networked lighting control systems.

B. Installer shall be factory-trained and certified for nLight systems.

C. All equipment shall be UL-listed and comply with applicable codes.

1.05 WARRANTY

A. Provide manufacturer's standard 5-year warranty for nLight devices.

B. Provide 1-year labor warranty for installation and programming.

PART 2 - PRODUCTS

2.01 LUMINAIRES

A. General

1. Additional WORK requirements are indicated in the Lighting Fixture Schedule on the Drawings. All luminaires, materials, and their installations shall be suitable for area classifications as noted on drawings and specifications.
2. LED luminaires that utilize exterior drivers that be serviced in place shall be provided with a disconnecting means either internal or external to each luminaire, in accordance with the requirements of Article 410.130(G)(1) of the 2020 NEC.

B. Provide a feed-through type or separate junction box.

C. Provide 2-lamp ballasts when possible.

D. Tandem-wire luminaires for 3-lamp fluorescent luminaires.

E. Provide minimum 18 AWG wire leads.

F. Provide components that are accessible and replaceable without removing the luminaire from the ceiling.

G. Soffit Installations

1. Installations shall be UL-labeled as "Suitable for Damp Locations."
2. Provide removable and prewired ballasts.

H. Exterior Installations

1. Installations shall be UL-labeled as "Suitable for Wet Locations."
2. Provide removable and prewired ballasts.
3. When factory-installed photocells are provided, the entire assembly shall be UL-labeled.

I. Emergency Lighting

1. Power Pack
   a. self-contained
   b. 120V
   c. 6 V sealed lead-calcium battery
   d. indicator switch in accordance with the requirements of UL 924
2. lighted, push-to-test pushbutton and indicator
3. capability of providing full illumination for 1-1/2 hours in emergency mode
4. capability of full recharge in 24 hours, automatically initiated upon resumption of normal line voltage
5. capability of protecting against excess charging and discharging
6. twin halogen, sealed lighting heads
7. solid state charger
8. normal and emergency LED indicating lights
9. Provide a 3-wire power cord and plug set.
10. mounting stand
11. time delay relays in order to maintain emergency lighting in areas illuminated by HID luminaires for 5 minutes after normal power has been restored.
12. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

J. Exit Signs

1. internally illuminated
2. universal mounting type
3. internal 6V sealed lead-calcium, maintenance free battery
4. battery charger
5. LED-type emergency and normal indicating lights
6. press-to-test button
7. directional arrows
8. red letters on a white panel

2.02 LAMPS

A. Light Emitting Diode (LED)

1. High
2. Efficiency Type: standard
3. Color: per schedule

B. Manufacturer, or Approved Equal

1. **Cooper Crouse (EATON)**
2. **Lithonia**

2.03 LED DRIVER

A. General

1. UL-Listed, ETL-certified
2. high power factor, energy-efficient type
3. Driver shall meet luminaire requirements.
4. LED driver shall be UL listed with integral short circuit, overload and overheat protection.
5. Power factor >90% and total harmonic distortion THD <20%.
6. Provide driver capable of operating on 120.
7. Driver shall have minimum 3 years warranty and rated for 50,000 hours.

2.04 LIGHTING CONTROL

A. Lighting Control Panel (LCP) – Relay Panel

1. Manufacturer:
    a. The relay panel shall be Acuity nLight ARP INTENC08 NLT 4FCR MVOLT 2VB HLK SM DTC or APPROVED EQUAL.
    b. Relay panel shall be provided with nDTC GUI TOUCH SCREEN.
    c. Provide nCOMKIT nLight Commissioning Kit
2. Design Criteria
    a. Multi-channel nLight-enabled relay panel with integral nLight network communication.
    b. Eight-relay architecture (INTENC08) with individually addressable and programmable relay outputs.
    c. MVOLT operation (120–277 V) with fully rated relay contacts for lighting branch circuit control.
    d. NLT (nLight-enabled) embedded network interface supporting autonomous and networked control modes.

e. 4FCR configuration supporting four feed-through controlled relays for coordinated switching.

f. 2VB dual-voltage barrier configuration for separation of Class 1 and Class 2 wiring.

g. HLK heavy-duty locking enclosure suitable for electrical room mounting and compliant with installation environment.

h. SM surface-mount enclosure with hinged access door and factory-installed terminal blocks.

i. DTC (Dimming/Time-Clock) functionality enabling time-based scheduling, photocell input processing, and integration with nLight devices.

j. Panel shall be fully compatible with nLight NPP series relay packs, plug-load packs, and emergency feed-through devices.

k. Provide UL-listed assembly meeting all applicable requirements of NEC and Title-24.

l. Provide integral low-voltage power supply for nLight network devices.

m. Provide factory-configured relay sequencing and programmable logic for occupancy, daylighting, and scheduling control.

n. Provide surge-protected electronics suitable for commercial lighting control applications.

o. Provide minimum 5-year warranty on the relay panel and control electronics.

p. Relay panel shall support network bandwidth and communication requirements for nLight digital lighting control systems.

q. Provide enclosure mounting hardware and all accessories required for complete installation.

B. Photocell

1. Manufacturer:

a. The photocell shall be Acuity nLight ARPA Photocell or approved equal.

2. Design Criteria:

a. nLight-enabled photocell providing automatic dusk-to-dawn control with integral nLight network communication.

b. Outdoor sensor open loop switching only to 1-3FC.

c. Compatible with nLight ARP relay panels.

C. Power Relay Pack

1. Manufacturer:

a. The power relay pack for lighting control systems shall be Acuity nLight nPP16 EFP or approved equal.

- nPP16 D EFP for 0–10V dimming lighting control.
- nPP16 EFP for standard ON/OFF switching.

2. Design Criteria:

a. 16A line-voltage switching relay and integral nLight network interface.

b. The device shall support 120–277 VAC input, drawing a maximum of 40 mA line current.

c. The unit shall provide 0–10V dimming control suitable for standard 0–10V LED drivers.

d. The device shall include External Fault Protection (EFP) to prevent damage from mis-wiring or abnormal load conditions.

e. The relay pack shall support occupancy-controlled operation, including Auto-On or Vacancy modes as selectable via nLight configuration.

f. The device shall be fully compatible with the nLight wired lighting control network, supporting digital communication, grouping, and remote configuration.

g. The unit shall provide integral low-voltage power for connected nLight devices per manufacturer specifications.

h. The housing shall be suitable for ½-inch knockout mounting or junction box installation, with surface-mount capability.

i. The relay hardware shall comply with applicable IEEE and UL electrical standards for low-voltage control equipment and support reliable operation on commercial building branch circuits.

D. Plug Load Control Power Pack

1. Manufacturer:

a. The power relay pack for lighting control systems shall be Acuity nLight nPP20 PL or approved equal.

2. Design Criteria:

a. 20A line-voltage switching relay suitable for lighting and plug-load control applications.

b. The device shall support 120–347 VAC input, with internal self-powered operation and no external transformer required.

c. The unit shall provide plug-load control functionality, enabling automatic shutoff of controlled receptacles per Title 24 requirements.

d. The relay pack shall include an integral nLight network interface, supporting digital communication, grouping, and remote configuration within the nLight wired network.

e. The unit shall provide integral low-voltage power for connected nLight devices per manufacturer specifications.

f. 8. The device shall operate within the manufacturer's rated environmental conditions and comply with UL 916 and UL 2043 listings for energy management and plenum-rated equipment.

g. 9. The relay hardware shall comply with applicable IEEE and UL electrical standards for branch-circuit control equipment and support reliable operation on commercial building circuits.

h. The device shall support switching control of one plug-load zone, with network expansion achievable through additional nLight devices.

E. Networked Light Switches

1. Standard ON/OFF light switching.

a. **nLight**: nPODMA

b. Or Approved Equal.

2. Dimming with ON/OFF light switching.

a. **nLight**: nPODMA DX LT

b. Or Approved Equal.

3. Dimming with ON/OFF + Occupancy Sensor light switching.

a. **nLight**: nWSXA LV DX

b. Or Approved Equal.

2.05 CONTROL NETWORK WIRING

A. Network cables and wiring shall be Class 2, low-voltage, per NEC Article 725.

B. Use manufacturer-approved cable types.

C. Maximum bus length and device count shall comply with system supplier design limits.

2.06 POLES

A. Rating (with luminaire): 125-mph steady winds without incurred damage.

B. Material: steel

PART 3 - EXECUTION

3.01 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.
2. Provide necessary hangers, pendants, canopies, and other accessories.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to the building and to concrete pole bases as required to safely mount the luminaire.
4. Install the luminaire plumb and level.
5. The mounting heights indicated for wall-mounted or pendant-mounted luminaires are from the bottom of the luminaire to finished floor or finished grade, whichever is applicable.
6. Install each luminaire outlet box with a galvanized stud.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.
2. Space single-stem hangers on continuous-row fluorescent luminaires 48 inches apart.
3. Provide twin-stem hangers on single luminaires.

C. Pole Mounting

1. Provide a cast-in-place concrete base.
2. Install the pole base flush with the finished grade where located in grassy areas not subject to vehicular traffic, and 30 inches above the finished grade when the pole is located in areas subject to damage from vehicular traffic.
3. Set the luminaire poles on anchor bolts and secure with double nuts on each bolt.
4. After the luminaire has been leveled and plumbed, dry-pack the luminaire base with grout.

D. Finished Areas

1. Install the luminaires symmetrically with tile pattern.
2. Locate with the centerline of tile or with centerline of the joint between adjacent tile runs.
3. Install recessed luminaires tight to the finished surface such that no spill light will show between the ceilings and the sealing rings.
4. When installing on combustible low-density cellulose fiberboard, provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use luminaires suitable for mounting on low-density ceilings.
5. Junction Boxes
    a. Flush and Recessed Luminaires: Locate a minimum of one foot from the luminaire.
    b. In concealed locations, install junction boxes to be accessible by the removal of the luminaire.

6. Wiring and Conduit
    a. Provide wiring of a suitable temperature rating as required by the luminaire.
    b. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.
8. Independent Supports
    a. Provide each recessed fluorescent luminaire with 2 safety chains or 2 No. 12 soft-annealed galvanized steel wires of length needed to secure the luminaire to the building structure, independent of the ceiling structure.
    b. Ensure that the tensile strength of chain or wire, and the method of fastening to the structure, is adequate to support the weight of the luminaire.
    c. Fasten the chain or wire to each end of the luminaire.

E. Unfinished Areas
1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.
2. Luminaire Suspension
    a. Provide 1/4-inch threaded steel hanger rods.
    b. Scissor-type hangers will not be accepted.
3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.02 LAMPS

A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.03 LED DRIVERS

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

B. Use LED driver mounting holes to fasten the driver securely within the luminaire.

C. Replace noisy or defective drivers.

3.04 LIGHTING CONTROL

A. General
1. Install all devices (relay panels, relay packs, sensors) per system installation manuals.
2. Provide dedicated neutral and hot feeds to each relay pack as required.
3. Maintain proper network topology for nLight communication buses, including daisy-chain wiring, addressing, and labeling.

B. Relay Panel Installation
1. Mount ARP enclosures plumb and square, in accessible locations compliant with NEC working-clearance requirements.
2. Terminate branch circuits, relays, and control wiring in accordance with panel schedules and manufacturer diagrams.
3. Provide surge protection and proper grounding for ARP equipment.
4. Label all relays, circuits, and control channels clearly and permanently.

C. Relay Pack Installation
1. Install relay packs in ceiling spaces, junction boxes, or equipment rooms as permitted by manufacturer instructions.
2. Provide line-voltage feed and switched output conductors sized per relay rating.

3. Ensure relay packs are accessible for maintenance and not buried behind inaccessible architectural elements.
4. Provide low-voltage nLight bus connections using manufacturer-approved cabling and connectors.
5. Verify correct addressing and device discovery during system startup.

D. Low-Voltage Network Wiring

1. Install Class 2 low-voltage control wiring in accordance with NEC Article 725.
2. Maintain separation from power conductors unless manufacturer permits shared raceways.
3. Label all network runs at both ends and provide cable routing diagrams.
4. Ensure maximum bus length, device count, and topology comply with system supplier design limits.

E. Photocell Operation

1. Provide photocell control to automatically switch luminaires ON at dusk and OFF at dawn.
2. Photocells shall be installed in locations free of stray light influence and oriented per manufacturer's recommendations.
3. Verify photocell sensitivity, switching thresholds, and correct operation during commissioning.

F. Time Clock Interface

1. Photocells shall energize the lighting control time clock at dusk.
2. The time clock shall switch designated luminaires **OFF at the programmed time**.
3. Coordinate photocell and time-clock logic to prevent overlap, short cycling, or nuisance switching.
4. Program time-clock schedules to meet Owner operational requirements and local code requirements.

G. Outdoor Luminaires

1. The photocells shall switch lights ON at dusk and OFF at dawn.
2. The photocells shall switch the time clock ON at dusk and the time clock shall switch lights OFF at the present time.

H. Dimming Systems

1. Install all dimming equipment, control modules, and low-voltage wiring in accordance with manufacturer's written instructions, NEC, and local codes.
2. Do not connect ballasts, drivers, or other equipment to the dimming system unless such connections are explicitly approved by the dimming system manufacturer.
3. Verify compatibility of all 0–10 V, or nLight-enabled drivers with the control system prior to installation.
4. Provide proper polarity, shielding, and separation of low-voltage control wiring from line-voltage conductors.

3.05 SYSTEM PROGRAMMING AND INTEGRATION

A. Device Discovery and Addressing

1. Use nLight Acuity software to discover all ARP relays, nPP16/nPP20 packs, sensors, and switches.
2. Assign logical device names, groupings, and zones per the lighting control intent drawings.

B. Relay and Zone Configuration

1. Program relay packs to operate per the sequence of operations, including photocell input, time-clock schedules, occupancy sensors, and manual override switches.
2. Configure ARP relays for fail-safe or fail-ON operation as required by code or Owner preference.

C. Dimming and Scene Control

1. Program dimming levels, daylighting response curves, and scene presets for all nLight-enabled luminaires.
2. Coordinate dimming zones with architectural layouts and Owner operational requirements.

D. Integration with Building Systems

1. Where required, integrate nLight system with network gateways.
2. Verify correct communication of relay status, occupancy events, and energy data.

3.06 FIELD QUALITY CONTROL AND TESTING

A. Pre-Functional Testing

1. Verify proper installation of all relay packs, ARP panels, sensors, and control wiring.
2. Confirm correct voltage, polarity, and grounding at all devices.
3. Test each relay for proper ON/OFF operation under manual and automatic control.

B. Functional Testing

1. Demonstrate photocell dusk/dawn operation and verify correct relay response.
2. Demonstrate time-clock schedules and confirm OFF events occur at programmed times.
3. Test occupancy sensors, daylight sensors, and wall stations for correct zone control.
4. Verify dimming performance, smooth transitions, and absence of flicker.

C. System Acceptance

1. Provide complete commissioning documentation, including device lists, zone maps, programming files, and test results.
2. Train Owner personnel on system operation, scheduling, and basic troubleshooting.
3. Submit final as-built drawings showing all nLight device locations, wiring routes, and addressing.

3.07 CLEAN-UP

A. Remove labels and other markings, except the UL listing mark.

B. Wipe the luminaires inside and out in order to remove construction dust.

C. Clean the luminaire plastic lenses with an antistatic cleaner only.

D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.

E. Replace defective lamps at the Date of Substantial Completion.

END OF SECTION

SECTION 16671
SURGE PROTECTION DEVICES (SPD)

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install surge protective devices (SPD).

B. SPDs furnished under this Section shall be ANSI/UL 1449 Type 2 integrating both surge suppression and high-frequency noise filtering suitable for use on low-voltage distribution systems.

C. The requirements of Section 16050 – General Electrical Work, apply to the WORK of this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Standards:

1. ANSI/UL 1449, Fourth Edition, Safety Surge Protective Devices
2. IEEE C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits
3. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connect to Low-Voltage (1000V and Less) AC Power Circuits
4. UL 1283, Safety Electromagnetic Interference Filters
5. NFPA 70, National Electric Code

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 16050 – General Electrical Work, General.

B. Shop Drawings:

1. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.

C. Product Data:

1. Manufacturer’s technical information, including catalog information.
2. Manufacturer's technical specifications with assembly and component ratings.

D. Certifications: Certification that SPD devices comply with standards referenced in this Section.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Shall have at least five (5) years’ experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least 5 installations in satisfactory operation for at least five (5) years each.

B. Component Supply and Compatibility:

1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.
2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

A. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.

B. SPD shall be suitable for operation under the following environmental conditions:

1. Relative Humidity: Zero to 95%, non-condensing
2. Frequency: 47 to 63 Hz
3. Temperature: Zero to 149°F
4. SPD operating voltage shall be suitable for the associated SPD location(s).
5. SPD shall be suitable for internal and external mounting. SPD shall be factory-mounted and integrated into distribution equipment specified under the following Sections:
   a. Section 16050 – General Electrical Work
   b. Section 16425 – Low Voltage Switchgear
   c. Section 16470 – Panelboards and General-Purpose Dry Type Transformers
   d. Section 16480 – Low Voltage Motor Control Centers

C. SPD shall include a surge suppression path for each mode as required for the system configuration. Each mode shall be individually fused and equipped with thermal cutouts. SPD short-circuit current rating shall be 200 kA. Protection modes shall include, to the extent applicable, the following:

1. Line-to-line
2. Line-to-neutral
3. Line-to-ground
4. Neutral-to-ground

D. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.

E. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115% of nominal system operating voltage.

F. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	**208Y/120**	**480Y/277**
L-N,L-G, N-G	800	1200
L-L	1200	2000

G. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following:

Category	**Application**	**Per Phase**	**Per Mode**
C	Service entrance	240 kA	120 kA
B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

H. Provide SPD equipped with the following accessories:

I. Surge counter with display for indicating the number of surges detected.

J. LED indicators for monitoring device status.

K. Audible alarm and silence switch for indicating an inoperative condition.

L. Dry contacts, “form C”, for remote annunciation of unit status.

M. Source Quality Control: Perform manufacturer’s standard factory tests on equipment. Tests shall be in accordance with ANSI/UL 1449.

N. Manufacturers: **General Electric, Eaton, Schneider Electric/Square D Company, or equal.**

PART 3 - EXECUTION

3.01 GENERAL

A. Install SPD in accordance with equipment manufacturer's written recommendations and instructions and the Contract Documents.

B. Where an SPD cannot be installed integral with the equipment to which it is connected, conductor length between suppressor and connection point shall be as short and as straight as possible.

END OF SECTION

SECTION 16950
ELECTRICAL TESTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section specifies the WORK necessary to test, commission, and demonstrate that the electrical work satisfies the criteria of these Specifications and functions as required by the Contract Documents.

B. The WORK of this Section includes furnishing the labor, equipment, and power required to support the testing indicated in other Divisions of these Specifications. Electrical testing indicated herein, and functional testing of power and controls not tested under Division 40 - Instrumentation, shall be completed before commencement of the facility testing as required by Division 01. This scope may require the CONTRACTOR to activate circuits, shutdown circuits, run equipment, make electrical measurements, replace blown fuses, and install temporary jumpers, etc.

C. The requirements of Section 16050 – General Electrical Work, apply to the WORK of this Section.

D. Carry out tests indicated herein for individual items of materials and equipment in other Sections. Testing shall be done in accordance with the manufacturer's instructions, these Specifications, and applicable NETA Acceptance Testing Specifications, NEMA, ANSI, NFPA, and ASTM Standards.

1.02 RELATED WORK

A.	Section 01300	Submittals
B.	Section 16050	General Electrical Work
C.	Section 16460	Electric Motors
D.	Section 16485	Industrial Control Panels
E.	Section 16120	Wire and Cabling
F.	Section 16450	Grounding
G.	Section 16110	Electrical Raceway Systems
H.	Section 16140	Wiring Devices
I.	Section 16111	Underground Raceway Systems
J.	Section 16470	Panelboards and General-Purpose Dry Type Transformers
K.	Section 16460	Low-Voltage Switchgear
L.	Section 16155	Low-Voltage Motor Control Centers
M.	Division 17	Process & Instrumentation Specifications

1. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with the WORK of equipment Specifications, the WORK of instrumentation Sections.

1.03 REGULATORY AGENCIES AND STANDARDS

A. Regulatory Agencies: Testing shall conform to the latest provisions of the following agencies:

1. NEC (NFPA 70) National Electrical Code: 2023 Edition

B. Standards: Where referenced in these specifications or on the drawings, the publications and standards of the following organizations apply:

1. ANSI American National Standards Institute
2. IEEE Institute of Electrical and Electronics Engineers

3. IEEE 400 – 2001, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems
4. IEEE 576 – 2000, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications
5. NETA InterNational Electrical Testing Association
6. NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
7. NETA MTS, Maintenance Testing Specifications for Electrical Power Equipment and Systems.

C. The publications listed above form a part of this specification to the extent referenced.

D. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of the Notice Inviting Bids shall be used.

1.04 SUBMITTALS

A. Submit in accordance with Section 01300 – Submittals.

B. Submit complete system test procedures for review. Test procedures shall include but not be limited to:

1. Detailed procedures in sufficient detail to verify conformance with these Specifications.
2. Incorporation of the Test Record Sheets included at the end of this Section.
3. Detailed comprehensive testing schedule including:
    a. Each major piece of electrical distribution equipment.
    b. Each major electrical subsystem.
    c. Duration of each test.
    d. Milestone test completion date.
    e. Ambient Conditions at time of test
    f. Date of test results submittals following completion of the tests.
    g. Names and qualifications of the individual(s) responsible for performing the testing.

C. Following completion of the test submit the completed test results to the Engineer for review. The results shall include a dedicated section with the “as-left” settings of all devices, relays, circuit breakers, etc.

D. Test result shall be submitted in one submittal

E. Test reports shall be based on NETA’s latest Acceptance Testing Specifications having a sign-off, pass/fail data filed for each line item covered by NETA’s Acceptance Testing Specifications latest edition.

1.05 COMMISSIONING

A. Commissioning shall only be attempted as a function of normal plant operation in which plant process flows and levels are routine and equipment operates automatically in response to flow and level parameters or computer command, as applicable. Simulation of process parameters shall be considered only upon receipt of a written request by the CONTRACTOR.

1.06 TESTING ORGANIZATION QUALIFICATIONS

A. Testing organization shall be corporately and financially independent of the supplier, producer and installer of the equipment.

B. Testing organization shall meet Federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, 1910 and 1936. Membership in the National Electrical Testing Association constitutes proof of meeting such criteria.

C. Testing organization shall provide all materials, equipment, labor and technical supervision to perform inspections and tests.

1.07 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:

1. Occupational Safety and Health Act.
2. Accident Prevention Manual for Industrial Operations, National Safety Council.
3. Applicable state and local safety operating procedures.
4. Owner's safety practices.
5. National Fire Protection Association - NFPA 70E
6. American National Standards for Personnel Protection

B. All tests shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.

C. The testing firm shall have a designated safety representative on the project to supervise the testing operations with respect to safety.

PART 2 - TESTING & REPORTS

2.01 PRE-ENERGIZATION AND OPERATING TESTS

A. The complete electrical system shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance with the recommendations of the protective device study and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the authority having jurisdiction.

1. Instrument Transformers. All instrument transformers shall be tested to verify correct polarity and burden.
2. Protective Relays. Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.
3. Switching Circuits. Each switching circuit shall be observed to operate the associated equipment being switched.
4. Control and Signal Circuits. Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.
5. Metering Circuits. All metering circuits shall be verified to operate correctly from voltage and current sources, similarly to protective relay circuits.
6. Acceptance Tests. Complete acceptance tests shall be performed, after the station installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.
7. Relays and Metering Utilizing Phase Differences. All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.

B. Test Report. A test report covering the results of the tests required in the Pre-Energization and Operating Tests shall be delivered to the authority having jurisdiction prior to energization. Acceptance Testing shall be in accordance with NETA ATS, Electrical Power Equipment and Systems.

PART 3 - EXECUTION

A. The following test requirements supplement test and acceptance criteria that may be stated elsewhere.

B. Perform Electrical Tests after electrical installation is 100% completed.

3.02 LIGHTING AND RECEPTACLES

A. Switching, include remote control, if present in system. Circuitry is in accordance with panel schedules. All interior and exterior lighting shall be checked for proper operation.

B. Test ground interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle manufacturer.

3.03 SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

A. Visual and Mechanical Inspection.

1. Inspect for physical, electrical and mechanical condition.
2. Compare equipment nameplate information with latest one-line diagram and report discrepancies.
3. Check for proper anchorage, required area clearances, physical damage and proper alignment.
4. Inspect all doors, panels and sections for paint, dents, scratches, fit and missing hardware.
5. Verify that fuse and/or circuit breaker sizes and types correspond to drawings.
6. Verify that current and potential transformer ratios correspond to drawings.
7. Inspect all bus connections for high resistance. Use low-resistance ohmmeter or check tightness of bolted bus joints by using a calibrated torque wrench.
    a. Refer to manufacturer's instructions or NETA ATS Table 100.12.
8. Test all electrical and mechanical interlock systems for proper operation and sequencing.
9. Closure attempt shall be made on locked open devices. Opening attempt shall be made on locked closed devices.
10. Clean entire switchgear using manufacturer's approved methods and materials.
11. Inspect insulators for evidence of physical damage or contaminated surfaces.
12. Verify proper barrier and shutter installation and operation.
13. Lubrication
    a. Verify appropriate contact lubricant on moving current carrying parts.
    b. Verify appropriate lubrication on moving and sliding surfaces.
14. Exercise all active components.
15. Inspect all mechanical indicating devices for proper operation.

B. Electrical Tests

1. Perform test on all instrument transformers in accordance with Instrument Transformer Section.
2. Perform ground-resistance tests in accordance with Grounding Systems Section.
3. Perform insulation-resistance test on each bus section, phase-to-phase and phase-to-ground for one (1) minute. Test voltages and minimum resistances shall be in accordance with NETA ATS, Table 100.1.
4. Perform insulation-resistance test on control wiring. Do not perform this test on wiring connected to solid-state components.

5. Perform control wiring performance test. Use the elementary diagrams of the switchgear to identify each remote control and protective device. Conduct tests to verify satisfactory performance of each control feature.
6. Perform secondary voltage energization test on all control power circuits and potential circuits as detailed below. Check voltage levels at each point on terminal boards and at each terminal on devices.
7. Perform current injection tests on the entire current circuit in each section of switchgear.
    a. Perform current test by primary injection, where possible, with magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit.
    b. Where primary injection is impractical, utilize secondary injection with a minimum current of 1.0 ampere.
    c. Test current at each device.
8. Determine accuracy of all meters per Metering and Instrumentation Section. Verify multipliers.
9. Control Power Transformers - Dry Type
    a. Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring and overall general condition.
    b. Verify proper primary and secondary fuse ratings or circuit breakers.
    c. Verify proper interlock function and contact operation.
    d. Perform insulation-resistance tests. Perform measurement from winding-to-winding and windings-to-ground. Test voltage and minimum resistances shall be in accordance with NETA ATS, Table 100.1. Results shall be temperature corrected in accordance with NETA ATS, Table 100.14.
    e. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check potential at all devices.
    f. Verify proper secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
10. Potential Transformer Circuits
    a. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check for proper potential at all devices.
    b. Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
11. Test circuit breakers in accordance with Circuit Breaker paragraphs.

C. Test Values

1. Bolt-torque levels shall be in accordance with NETA ATS Table 100.12, unless otherwise specified by manufacturer.
2. Insulation-resistance test shall be performed in accordance with NETA ATS, Table 100.1. Values of insulation resistance less than this table or manufacture's minimum should be investigated.

3.04 LOW-VOLTAGE CABLES-600V MAXIMUM

A. Visual and Mechanical Inspection

1. Compare cable data with drawings and specifications.
2. Inspect exposed sections of cables for physical damage and proper connection in accordance with single-line diagram.

3. Inspect bolted electrical connections for high resistance using one of the following methods:
    a. Use of low-resistance ohmmeter
    b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS, Table 100.12.
4. Inspect compression-applied connectors for correct cable match and indentation.
5. Inspect for correct identification, arrangements, and cable color coding.
6. Inspect cable jacket insulation and condition.

B. Electrical Tests

1. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.
    a. Motor feeders shall be tested with motors disconnected and controller open.
    b. Motor control circuits shall be tested and verified for proper operation with control stations and overcurrent devices connected.
    c. Panelboard feeders shall be tested with feeder breaker open and panel-board connected. If a lighting transformer is associated with the panelboard, it shall be connected and the test made for both primary and secondary sides.
    d. Conductors of main lighting feeders, including lighting panel shall be tested with branch circuits open.
2. Prior to performing insulation resistance tests on cables, verify that they are not connected to a solid-state device.
    a. Equipment shall be disconnected to avoid damage during prior to testing.
    b. The CONTRACTOR shall notify Engineer if minimum insulation values cannot be obtained.
3. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
4. Perform continuity test to insure correct cable connection.

C. Test Values – Visual and Mechanical

1. Compare bolted connection resistance to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2. Bolt-torque levels should be in accordance with NETA ATS, Table 100.12 unless otherwise specified by the manufacturer.

D. Test Values – Electrical

1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated to determine cause of deviations.
3. Cable shall exhibit continuity.
4. Deviations in resistance between parallel conductors shall be investigated to determine cause of deviations.

3.05 CIRCUIT BREAKERS - LOW-VOLTAGE - INSULATED-CASE

A. Visual and Mechanical Inspection

1. Check circuit breaker for proper mounting and compare nameplate data to drawings and specifications.
2. Operate circuit breaker to ensure smooth operation.
3. Inspect case for cracks or other defects.
4. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS- 2017, Table 100.12.

B. Electrical Tests

1. Perform a contact-resistance test.
2. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.
3. Determine long-time minimum pickup current by primary current injection where practical.
4. Perform long-time delay time-current characteristic test by passing three hundred percent (300%) rated current through each pole separately. Record trip time.
5. Determine short time pickup and delay by primary current injection.
6. Determine ground-fault pickup and time delay by primary current injections.
7. Determine instantaneous pickup current by primary injection using run-up or pulse method.

C. Test Values

1. Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Values of resistance less than this table or manufacturer's recommendations shall be investigated to determine cause of deviations.
2. Insulation resistance shall not be less than 100 megohms.
3. Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4. All trip times shall fall within Table ICO. Circuit breakers exceeding specified trip time at three hundred percent (300%) of pickup shall be tagged defective.
5. Instantaneous pickup values shall be within values shown on Table ICI.

Table ICO
Insulated-Case Circuit Breaker Overcurrent Trip Test
(At 300% of Rated Continuous Current of Circuit Breaker)

Maximum Breaker Voltage Volts	Range of Related Continuous Current Amperes	Maximum Trip Time in Seconds*
240	15-45	50
240	50-100	70
600	15-45	70
600	50-100	125
240	110-225	200
240	250-400	300
600	110-225	250

Table ICO Insulated-Case Circuit Breaker Overcurrent Trip Test (At 300% of Rated Continuous Current of Circuit Breaker)		
Maximum Breaker Voltage Volts	**Range of Related Continuous Current Amperes**	**Maximum Trip Time in Seconds***
600	250-400	300
600	450-600	350
600	700-1200	500
600	1400-2500	600
600	3000-5000	650

*For integrally-fused circuit breakers, trip times may be substantially longer if tested with the fuses replaced by solid links (shorting bars).

Table ICI Insulated-Case Circuit Breaker Instantaneous Trip Tolerances		
Frame Size, Amperes	**Tolerances of High and Low Settings**	
	High	**Low**
<250	+40% -25%	+40% -30%
>400	+25%	+30%

3.06 CIRCUIT BREAKERS - LOW-VOLTAGE - POWER

A. Visual and Mechanical Inspection

1. Inspect for physical damage and compare nameplate data with drawings and specifications.
2. Perform mechanical operation test in accordance with manufacturer's instructions.
3. Check cell fit and element alignment and proper operation of racking interlocks.
4. Bolt-torque levels should be in accordance with NETA ATS, Table 100.12 unless otherwise specified by the manufacturer.
5. Check arc chutes for damage.
6. Clean entire circuit breaker using approved methods and materials.
7. Lubricate as required.

B. Electrical Tests

1. Perform a contact-resistance test.
2. Perform an insulation-resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
3. Determine long-time minimum pickup current by primary current injection.
4. Determine long-time delay by primary injection.
5. Determine short-time pickup and delay by primary current injection.
6. Determine ground-fault pickup and delay by primary current injection.
7. Determine instantaneous pickup value by primary current injection.
8. Make adjustments for final settings in accordance with breaker setting sheet.

9. Activate auxiliary protective devices, such as ground-fault or under voltage relays, to ensure operation of shunt trip devices. Check the operation of electrically-operated breakers in their cubicle.
10. Check charging mechanism.

C. Test Values

1. Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%).
2. Insulation resistance shall not be less than 100 megohms. Investigate values less than 100 megohms.
3. Trip characteristics of breakers when adjusted to setting sheet parameters shall fall within manufacturer's published time-current tolerance band.

3.07 PROTECTIVE RELAYS

A. Visual and Mechanical Inspection

1. Inspect relays for physical damage and compliance with drawings and specifications.
2. Inspect cover gasket for proper seal; clean cover glass; check for foreign material, particularly in disc slots of permanent and electromagnets; check disk clearance; check conditions of spiral spring and case contacts.
3. Check for freedom of movement, proper travel and alignment, and tightness of mounting hardware and tap plugs.
4. Set relays in accordance with approved settings from Specification Section [16431] [260573] – Protective Device Studies.

B. Electrical Tests

1. Perform insulation-resistance test on each circuit-to-frame. Do not perform this test on solid-state devices.
2. Perform the following tests at the recommended trip settings.
3. Pickup parameters on each operating element.
4. Perform timing test at two (2) points on time-current curve.
5. Pickup target and seal-in units.
6. Special tests as required to check operation of restraint, directional, and other elements per manufacturer's instruction manual.
7. Perform phase-angle and magnitude contribution tests on all differential and directional-type relays after energization to vectorially prove proper polarity and connection.

3.08 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection

1. Inspect for physical damage and nameplate information for compliance with drawings and specifications.
2. Verify proper connection of transformers with system requirements.
3. Verify tightness of all bolted connections and assure that adequate clearances exist between primary circuits and secondary circuit wiring.
4. Verify that all required grounding and shorting connections provide good contact.
5. Test proper operation of transformer withdrawal mechanism (tip out) and grounding operation when applicable.
6. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests - Current Transformers

1. Perform insulation-resistance test of the current transformer and wiring-to-ground at 1000V dc. Do not perform this test on solid-state devices.
2. Perform a polarity test of each current transformer.
3. Perform a ratio-verification test using the voltage or current method in accordance with ANSI C57.13.1.
4. Perform an excitation test on transformers used for relaying applications in accordance with ANSI C57.13.1.
5. Measure relaying circuit burdens at transformer terminals and determine the total burden in ohms at 60Hz.
6. When applicable, perform insulation-resistance and dielectric withstand tests on the primary winding with secondary grounded. Test voltages shall be per NETA ATS, Table 100.1 and ITD respectively.

C. Electrical Tests - Voltage Transformers

1. Perform insulation-resistance tests winding-to-winding and windings-to-ground. Test voltages shall be applied for one (1) minute in accordance with NETA ATS, Table 100.1. Do not perform this test with solid-state devices connected.
2. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable.
3. Perform a ratio test using a transformer-turns-ratio test set or by voltage comparison method.
4. Perform a dielectric withstand test on the primary windings with the secondary windings connected-to-ground. The dielectric voltage shall be in accordance with Table ITD and applied for one (1) minute.

D. Test Values

1. Insulation-resistance measurement on any instrument transformer shall be not less than that shown in NETA ATS, Table 100.1.
2. Perform a burden/saturation calculation on current transformers supplying relaying circuits.
3. Ratio accuracies shall be within 0.5% of nameplate or manufacturer's specifications.
4. Withstand tests shall be evaluated as pass/fail.

Table ITD
Instrument Transformer Dielectric Test Voltage

Nominal System Voltage	Test BIL (kV)	Dielectric Withstandability Field Test Voltage (kV)	
		AC	DC
2.4	45	11.3	15
4.8	60	14.3	19
13.8	95	25.5	34
13.8	110	25.5	34
25	125	30.0	40
25	150	37.5	50

Table is derived from paragraph 8.8.2 and tables 2 and 7 of ANSI/IEEE C57.13, "Standard Requirements for Instrument Transformers."

3.09 METERING AND INSTRUMENTATION

A. Visual and Mechanical Inspection

1. Examine all devices for broken parts, shipping damage, and tightness of connections.
2. Verify that meter types, scales, and connections are in accordance with drawings and specifications.

B. Electrical Tests

1. Determine accuracy of meters at 25/50/75/100% of full scale for each metered parameter.
2. Calibrate meters to one-half percent (0.5%).
3. Verify all instrument multipliers.

3.10 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Inspect ground system for compliance with contract documents and NFPA 70 National Electrical Code Article 250.
2. Inspect physical and mechanical conditions.
3. Inspect bolted electrical connection for high resistance using one or more of the following methods:
   a. Use of low-resistance ohmmeter
   b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench methods in accordance with manufacturer published data and NETA ATS Table 100.12.
4. Inspect anchorage.

B. Electrical Tests

1. Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System." Instrumentation utilized shall be as defined in Section 12 of the above guide and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten in the 62% area of the distance between the item under test and the current electrode.
2. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points.

C. Test Values

1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2. The resistance between the main grounding electrode and ground shall be no greater than five ohms for large commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference ANSI/IEEE Standard 142).
3. Investigate point-to-point resistance values that exceed 0.5 ohm.

3.11 GROUND-FAULT SYSTEMS (NEC 230-95)

A. Visual and Mechanical Inspection

1. Inspect for physical damage and compliance with drawings and specifications.
2. Inspect neutral main bonding connection to assure:
   a. Zero-sequence sensing system is grounded.
   b. Ground-strap sensing systems are grounded through sensing device.
   c. Ground connection is made ahead of neutral disconnect link on zero-sequence sensing systems.
   d. Grounded conductor (neutral) is solidly grounded.

3. Inspect control power transformer to ensure adequate capacity for system.
4. Manually operate monitor panels (if present) for:
    a. Trip test
    b. No trip test
    c. Nonautomatic reset
5. Record proper operation and test sequence.
6. Set pickup and time-delay settings in accordance with the settings provided by the owner/user's electrical engineer.

B. Electrical Tests

1. Measure system neutral insulation resistance to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.
2. Determine the relay pickup current by current injection at the sensor and operate the circuit interrupting device.
3. Test the relay timing by injecting three hundred percent (300%) of pickup current, or as specified by manufacturer.
4. Test the system operation at fifty-seven percent (57%) rated control voltage, if applicable.
5. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
6. On multiple sources, tie breaker, etc., systems, devise a simulation scheme that fully proves correct operation.

C. Test Parameters

1. System neutral insulation shall be a minimum of one hundred (100) ohms, preferably one (1) megohm or greater.
2. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves but in no case longer than one (1) second for fault currents equal to or greater than 3,000 amperes.
3. Relay pickup value shall be within +/-10% of setting and in no case greater than 1200A.

3.12 AC MOTORS

A. Visual and Mechanical Inspection

1. Inspect for physical damage and compare nameplate data with drawings and specifications.
2. Inspect for proper anchorage, mounting, grounding, connection, and lubrication.
3. When applicable, perform special tests such as air gap spacing and pedestal alignment.
4. Check for unusual mechanical or electrical noise or signs of overheating during initial test run.

B. Electrical Tests - Induction Motors

1. Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.
2. Motor 200 HP and Less - Test duration shall be one minute with resistances tabulated at thirty and sixty seconds. Calculate the dielectric absorption ratio.
3. Motor Larger than 200 HP - Test duration shall be ten minutes with resistances tabulated at thirty seconds, one minute, and ten minutes. Calculate the dielectric absorption ratio and polarization indexes.
4. Perform insulation-resistance test on pedestal per manufacturer instructions.
5. Test motor starter prior to energizing the motor.

6. Check resistance temperature detector (RTD) circuits for conformance with drawings. Check that metering or relaying devices using the RTD's are of the proper rating.
7. Check that the motor space heater circuit is in proper operating condition and in accordance with drawings and specifications.
8. Check all protective devices in accordance with other sections of these specifications.
9. Perform a rotation test to ensure proper shaft direction.
10. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.
11. Perform vibration tests: Motors Larger than 200 HP - Perform vibration base-line test. Amplitude shall be plotted versus frequency. For motors 200 HP and less perform vibration and amplitude test.

C. Test Values

1. Perform insulation-resistance tests at the test voltage listed in NETA ATS, Table 100.1. Investigate dielectric absorption ratios less than 1.4 and polarization index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
2. Vibration amplitudes shall not exceed values shown in Table MAV.
3. Salient pole voltage drop should be equal for each pole. Investigate values that differ by more than ten percent (10%).

Table MAV
Maximum Allowable Vibration Per NEMA MG-1

Speed RPM	Amplitude Inches Peak-to-Peak
3000 and above	0.001
1500-2999	0.0015
1000-1499	0.002
999 and below	0.0025

3.13 LOW-VOLTAGE MOTOR CONTROL CENTERS

A. Visual and Mechanical Inspection

1. Inspect for physical damage, proper anchorage, and grounding.
2. Inspect equipment for compliance with drawings and specifications.
3. Motor-running protection:
   a. Compare overload heater rating with motor full-load current rating to verify proper sizing. (Adjust as necessary if power factor correction capacitors are connected on load side of heaters.)
4. Check tightness of bolted connections using calibrated torque wrench.

B. Electrical Tests

1. Insulation tests:
   a. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground for one (1) minute. Test voltage shall be in accordance with NETA ATS, Table 100.1.
   b. Measure insulation resistance of each starter section phase-to-phase and phase-to-ground with the starter contacts closed and the protective device open. Test voltage shall be in accordance with NETA ATS, Table 100.1.
   c. Measure insulation resistance of each control circuit with respect to ground. Refer to NETA ATS, Table 100.1. Do not perform this test on wiring connected to solid-state components.

2. Test motor overload units by injecting current through overload unit and monitoring trip time at three hundred percent (300%) of motor full-load current.
3. Test molded-case breakers per Low Voltage Insulated Case Circuit Breakers paragraphs.
4. Perform operational tests by initiating control devices to affect proper operation.
5. Determine accuracy of all meters per Metering and Instrumentation paragraphs.
6. Test protective devices in accordance with Protective Relay paragraphs.

C. Test Values

1. Bolt-torque levels should be in accordance with NETA ATS, Table 100.12 unless otherwise specified by the manufacturer.
2. Insulation-resistance test results shall conform with NETA ATS, Table 100.1.
3. Control wiring-insulation test voltage shall be 500V dc for 300-volt rated cables and 1000V dc for 600-volt rated cables. Do not perform this test on wiring connected to solid-state components.
4. Perform overload tests at three hundred percent (300%) of motor full-load current. Trip times shall be in accordance with manufacturer's tolerances. Investigate values in excess of one hundred twenty (120) seconds.

3.14 TRANSFORMERS – SMALL DRY-TYPE, AIR-COOLED (600 Volt and Below, less than 100 kVA single-phase or 1000 kVA three-phase)

A. Inspect for physical damage, broken insulation, tightness of connections, defective wiring and general condition.

B. Thoroughly clean unit prior to making any tests.

C. Perform insulation-resistance test. Calculate dielectric absorption ratio and polarization index. Make measurements from winding-to-winding and windings-to ground. Test voltages and minimum resistance shall be in accordance with NETA ATS, Table 100.5. Results shall be temperature corrected in accordance with NETA ATS, Table 100.14.

D. Verify taps and connect transformer to desired tap, is applicable.

E. Energize primary winding with system voltage. Measure secondary voltage with the secondary load disconnected. Record results.

F.

G. A functional test and check of electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Functional testing shall comprise:

1. Visual and physical check of cables, circuit breakers, transformers, and connections associated with each item of new and modified equipment.
2. Verification that electrical equipment has been labeled with Arc Flash protection boundary and PPE levels, as required by Section 16431 – Protective Device Studies.
3. Setting of protective relays in conformance with results of the Short Circuit Study required by Section 16431 - Protective Device Studies and testing of relays to assure that relays will trip at the current value and time required by the Study.
4. Circuit Breakers
    a. Circuit breakers that have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field-adjusted by a representative of the circuit breaker manufacturer.
    b. Time and pickup setting shall correspond to the recommendations of the Short Circuit Study.

c. Setting shall be tabulated and proven for each circuit breaker in its installed position.

d. Test results shall be certified by the person performing the tests and shall be submitted to the ENGINEER.

H. Complete ground testing of grounding electrodes per requirements below prior to operating the equipment.

I. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the ENGINEER and after process control devices have been adjusted as accurately as possible. Alarm conditions shall be simulated for each alarm point, and alarm indicators shall be checked for proper operation. It is intended that the CONTRACTOR will adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.

J. Metering and indication lights for motors and other devices shall be tested for proper operation.

K. All control circuits such as motor, interlock and remote shall be tested for proper operation.

L. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.

M. Motor operated valves shall be tested after having been phased and tested for correct motor rotation and after travel and torque limit switches have been adjusted by a representative of the valve manufacturer. Tests shall verify status indication, proper valve travel, and correct command control from local and remote devices.

N. All lighting panels, circuits and fixtures; and power panels, circuits and receptacles shall be tested for proper operation.

O. Provide ground resistance tests on the main grounding electrode or system in the presence of the ENGINEER and submit results

1. Visual and Mechanical Inspection

a. Verify ground system is in compliance with drawings and specifications.

2. Electrical Tests

a. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on the main grounding electrode or system.

b. The earth resistance of each ground electrode shall be measured and recorded before electrodes are connected to the grounding loop.

c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3. Test Values

a. The resistance between the main grounding electrode and ground shall be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner.

b. Investigate point-to-point resistance values which exceed 0.5 ohm.

P. Subsystems shall be defined as individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, etc.

3.15 TEST REPORTS

A. The test report shall include the following:

1. Summary of project.

2. Description of equipment tested.
3. Description of test.
4. Test data.
5. Analysis and recommendations.

B. Test data records shall include the following minimum requirements:
1. Identification of the testing organization.
2. Equipment identification.
3. Humidity, temperature, and other atmospheric conditions that may affect the results of the tests/calibrations.
4. Date of inspections, tests, maintenance, and/or calibrations.
5. Identification of the testing technician.
6. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
7. Indication of expected results when calibrations are to be performed.
8. Indication of “as-found” and “as-left” results.
9. Sufficient spaces to allow all results and comments to be indicated.

C. The testing firm shall furnish a copy or copies of the complete report to the owner as required in the acceptance contract.

END OF SECTION

SECTION 17010
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR shall provide Instrumentation and Control System (I&CS) complete and operable, in accordance with the Contract Documents.

B. The Division 17 drawings and specifications are to be read together with drawings and specifications of all other Divisions and specifically Division 16. Additional information necessary to complete the work is included in other sections of the drawings and specifications.

C. The requirements of this Section apply to every component of the I&CS unless indicated otherwise.

D. All tables shown of the Division 17 drawings and specifications are for information purposes only and may show partial lists of equipment and materials. A complete take-off from all drawings and specifications shall be done by the CONTRACTOR in order to determine accurate quantities of equipment and materials

1.02 DEFINITIONS AND ACRONYMS

A. System Supplier**:**

1. The System Supplier shall be a single firm, corporation, or other entity assuming full responsibility through the CONTRACTOR to perform all engineering and to select, furnish, integrate, supervise the installation and connections, test, calibrate, and place into operation all instrumentation, controls, communication hardware and software. The System Supplier shall specialize and have an experienced engineering and technical staff in the design, integration, and supply of systems similar to the one in these Contract Documents.

B. City Programmer:

1. The City Programmer shall be a single firm, engaged directly through the Cityt and assuming full responsibility to perform all programming, configuration, modification, and technical implementation required for the SCADA system and associated control/communication infrastructure. The City Programmer shall develop, modify, integrate, and validate all PLC/Remote I/O code, local operator panel (LOP) logic, network configuration (less vendor provided system configuration), and related control-system software necessary to meet the functional requirements of the CONTRACT DRAWINGS.

C. AI/AO Analog Input/Output

D. CMMS Computerized Maintenance Management SysteM

E. DI/DO Digital Input/Output

F. FOC Fiber Optic Cable

G. HMI Human Machine Interface

H. HSE High Speed Ethernet

I. I/O Input/Output Signals

J. LAN Local Area Network

K. LIMS Laboratory Information Management System

L. MM Multimode (Fiber)

M. OIT Operator Interface Terminal

N. OPC OLE for Process Control (communication interface driver)

O. PID Proportional, Integral and Derivative Process Controller

P. PLC Programmable Logic Controller

Q. PS Pump Station

R. RAM Random Access Memory

S. SCADA Supervisory Control and Data Acquisition

T. SM Single Mode (Fiber Optic)

U. UPS Uninterruptible Power Supply

V. WAN Wide Area Network

W. WTP Water Treatment Plant

X. WWTP Wastewater Treatment Plant

1.03 RESPONSIBILITIES

A. The CONTRACTOR, through the use of a single System Supplier and qualified electrical and mechanical installers, shall be responsible to the OWNER for the implementation of the I&CS and the integration of the I&CS with other required network and control devices.

B. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these specifications that the System Supplier will be responsible to the CONTRACTOR for the integration of the I&CS with existing devices and devices provided under this and other Divisions with the objective of providing a completely integrated control system free of signal incompatibilities.

1. CONTRACTOR and System Supplier must make the new I&CS work seamlessly with all existing field devices, panels, wiring, power systems, networks, and control logic, ensuring there are no signal, power, communication, or functional incompatibilities. This includes verifying existing conditions, modifying existing panels, resolving mismatched signals, updating wiring, and ensuring the City Programmer can successfully implement SCADA/PLC logic with the existing and new hardware.

C. As a minimum, the implementation of the I&CS by the CONTRACTOR shall include the following WORK:

1. Integrate the I&CS with existing devices and systems provided under this and other Divisions
2. Prepare the required I&CS submittals
3. Design and develop project-wide loop diagrams including those associated with equipment provided under other Divisions and OWNER-furnished and existing equipment
4. Design and develop control panel drawings
5. Field verify existing conditions
6. Prepare factory and field test submittals
7. Prepare training plan
8. Prepare spare parts submittal
9. Procure hardware and software
10. Configure and factory test the I&CS
11. Bench calibrate instruments and verify calibration after installation
12. Terminate signals inside control and network panels; terminate communication and network devices and nodes
13. Supervise and coordinate installation and termination of field signals, power, and utilities associated with the I&CS. Resolve signal, power, or functional incompatibilities between the I&CS and new and existing interfacing devices.

14. Loop test in accordance with the loop diagrams. Validate and certify loops
15. Oversee, document, and certify system commissioning
16. Conduct system performance test
17. Prepare technical manuals
18. Conduct training classes
19. Prepare I&CS as-built final construction drawings

D. Any Instrumentation Supplier responsibilities in addition to the list above are at the discretion of the CONTRACTOR and the Instrumentation Supplier. Additional requirements in this Section and throughout Division 17 that are stated to be the CONTRACTOR's responsibility may be performed by the Instrumentation Supplier if the CONTRACTOR and Instrumentation Supplier so agree.

E. The CONTRACTOR shall be responsible for coordinating and scheduling the City Programmer for start-up and testing requirements required as part of this project.

1.04 RELATED WORK

A. Section 17010 Instrumentation and Control for Process Systems

B. Division 16 Electrical Specifications

C. All electrical work required under this section shall conform to the requirements of Division 17 and the applicable requirements of Division 01, Division 16.

1.05 REGULATORY AGENCIES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all WORK specified herein shall conform to or exceed the applicable requirements of the referenced documents to the extent that the requirements therein are not in conflict with the provisions of this Section; provided, that where such documents have been adopted as a code or ordinance by the public agency having jurisdiction, such code or ordinance shall take precedence.

B. The I&CS WORK shall conform to or exceed the applicable regulations, standards, specifications, and codes which are referenced in Section 014219 Reference Standards, and current as of the date of the final inspection for this Contract, including, but not limited to, those which are established by the following sources:

1. The International Society of Automation (ISA)
2. National Electrical Code (NEC)
3. National Fire Protection Association (NFPA)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. Occupational Safety and Health Administration (OSHA)
6. American National Standards Institute (ANSI)
7. National Electrical Manufacturers Association (NEA)
8. Insulated Cable Engineers Association (ICEA)
9. Local Power and Telephone Companies
10. Local Authorities having jurisdiction over the work
11. Federal Communication Commission (FCC)
12. Underwriter Laboratory (UL)

C. Where the requirements set forth in these Specifications or on the Drawings are greater or more rigid than the mandatory requirements referenced above, the applicable Specifications or Drawings shall govern.

D. In the case of conflict between any mandatory requirements and Specifications or Drawings, the mandatory requirement shall be followed in each case, but only after submitting such proposed changes to the ENGINEER for approval.

E. Nothing contained in these Specifications or shown on the Drawings will be so construed to conflict with any national, state, municipal, or local laws or regulations governing the installation of work specified herein, and all such acts, ordinances, and regulations, including the National Electrical Code, are hereby incorporated and made a part of these Specifications. All such requirements will be satisfied by the CONTRACTOR at no additional expense to the OWNER.

F. The Drawings and Specifications are complementary to each other; what is called for by one shall be as binding as if called for by both. If a conflict between Drawings and Specifications is discovered, this shall be referred to the ENGINEER as soon as possible for resolution. Should a conflict exist between the Drawings, Specifications, and/or mandatory requirements (i.e., codes, ordinances, etc.), it will be assumed that the more expensive method has been estimated, unless such alternate has been agreed to prior to submission of bids.

1.06 SUBMITTALS

A. The CONTRACTOR shall coordinate the I&CS part of the WORK so that a complete instrumentation and control system will be provided and will be supported by accurate Shop Drawings and as-built drawings.

B. The submittals and their schedules shall be in accordance with the requirements listed below: Any incomplete submittal will be rejected and returned without comments.

C. Interface between instruments, motor control centers, engines, starters, control valves, flowmeters and other equipment related to the I&CS shall be included in the shop drawing submittal. Interface between existing equipment, instruments and control panels shall also be included.

D. The following information shall be submitted per Section 16050 General Electrical Work and shall include but not be limited to:

1. Equipment descriptive data, including equipment tag as identified in the contract documents.
2. Full manufacturer's part number indicating all selected options.
3. Equipment installation, service manuals, operation/maintenance manuals and recommended spare parts lists.
4. Schematics and interconnecting wiring diagrams.
5. Records of conductor identification, field terminals, changes, etc.
6. Instrumentation and control panel shop drawings, face layouts, schematics and point-to-point wiring diagrams.
7. Ethernet network control system architecture drawings complete with wiring identification numbers.
8. Records of as-built information for the control system components.

E. Symbols and Nomenclature: In these Contract Documents, systems, meters, instruments, and other elements are represented schematically, and are designated by symbols as derived from Instrument Society of America Standard ISA S5.1 - Instrumentation Symbols and Identification. The nomenclature and numbers designated herein and on the Drawings shall be employed exclusively throughout Shop Drawings, and similar materials. No other symbols, designations, or nomenclature unique to the manufacturer's standard methods shall replace those prescribed above, used herein, or on the Drawings.

F. Shop Drawings shall include the letter head or title block of the System Supplier. The title block shall include, as a minimum, the System Supplier's registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing.

1. Organization of the Shop Drawing submittals shall be compatible with eventual submittals for later inclusion in the Technical Manual. Submittals not so organized will not be accepted.
2. For a project with multiple sites the CONTRACTOR shall provide a separate and unique set of drawings for each site.
3. Drawings that require more than one sheet due to space limitation or continuation in the subject of the drawings (e.g. loop diagrams, etc.) shall be given the same drawing number but with different sheet number (e.g. sheet 1 of x, sheet 2 of x, etc.).
4. Each submittal shall include a complete index appearing in the front of each bound submittal volume. Drawings and/or system groups shall be separated by labeled tags. The organization of the initial shop drawing submittal required above shall be compatible to eventual inclusion with the Technical Manuals submittal and shall include final alterations reflecting as-built conditions.
5. Interfaces between new and existing instruments, motor starters, control valves, variable speed drives, flow meters, chemical feeders, panels, and other equipment related to the I&CS shall be included in the Shop Drawing submittal.

G. Field Instrument Submittal

1. Submittal Schedule: The CONTRACTOR shall submit for approval a complete field and process instrument submittal, **all at one time, within** 60 **calendar days** after the date of Notice to Proceed is given to the CONTRACTOR.
2. Submittal Contents: The submittal shall include a complete index which lists each device by tag number, type, and manufacturer in accordance with the specified data sheets provided in this CONTRACT. A separate manufacturer technical brochure or catalog sheet shall be included with each specified instrument data sheet. If, within a single system or loop, a single instrument is employed more than once, one manufacturer brochure or catalog sheet may cover multiple identical uses of that instrument in that system. Each manufacturer brochure or catalog sheet shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags. Special options and features which are furnished shall be identified.

H. System Hardware Submittal:

1. Submittal Schedule: The CONTRACTOR shall submit for approval a complete system hardware submittal, **all at one time, within** 90 **calendar days** after the date of Notice to Proceed is given to the CONTRACTOR. This submittal shall be submitted together with the submittal for the System Architecture, and Communication Diagrams submittal and the Project-Wide Wiring Diagrams and Panel Drawings submittal specified below.
2. Submittal Contents:
    a. The submittal shall be for the hardware specified under Sections 17110 - Control Panels.
    b. The submittal shall include a complete index which lists each device by type, and manufacturer in accordance with the contract documents. A separate manufacturer technical data sheet or brochure shall be included for each hardware component. If, within a single system a single component is employed more than once, one manufacturer technical data sheet or brochure may cover multiple identical uses of that component in that system. Special options and features which are furnished shall be identified.
    c. The submittal shall include load calculations and size of the various UPS systems to demonstrate that the UPS is able to accommodate present and future load requirements, as well as overload capacity requirements.
    d. Spare Parts and Tools List: A list of spare parts and tools shall be submitted, covering items which are specified and furnished under this Contract. The list shall include the name, address, and phone number of manufacturer and manufacturer's local service

representative of these parts. The list shall also include recommended spare parts and tools, quantities and prices from which the OWNER will select the "Additional Recommended Spare Parts and Tools".

I. Project-Wide Wiring Diagrams and Panel Drawings Submittal

1. Submittal Schedule: The CONTRACTOR shall submit for approval a complete set of project-wide wiring diagrams (PWWD) and panel drawings, **all at one time within** 120 **calendar days** after the date of Notice to Proceed is given to the CONTRACTOR. The PWWD and panel drawings shall be a singular complete hard copy bound package and accompanied with a PDF on a CD. This submittal shall be submitted together with the System Hardware submittal and the System Architecture and Communication Diagrams submittal specified herein.

2. Submittal Contents: The PWWD and panel drawings shall be submitted as a single and comprehensive set of drawings. The submittal shall include a complete index in the front of each part of the submittal. The drawings shall be indexed by systems, sites, or process areas. Diagrams shall be tagged in a manner consistent with the Contract Documents and shall include the following:

   a. Project-Wide Wiring Diagrams: The PWWD shall define and document the contents of each analog and discrete monitoring, alarming, hardware interlock, and control functions associated with equipment provided under Division 17 sections. The PWWD shall also cover equipment provided under sections in other Divisions, existing, and OWNER-furnished equipment. The PWWD shall also include both field and panel wiring diagrams.

      - Drawings showing definitive diagram for every analog and discrete instrumentation loop system. These diagrams shall show and identify each component in each loop or system using legend and symbols from the standards in the Contract Documents. The wiring diagrams shall be presented on an 11"x17" drawing with no more than 10 loops per drawing.
      - In general, loops shall be grouped and organized by PLC (if used) and the I/O cards within the PLC. Each I/O card shall be presented on a separate sheet(s) and on the right side of the drawing. The type of card, part number and its slot location shall be identified. Each I/O shall be identified as well as its location on the card and its address. Existing, spare, and future I/Os shall also be shown. Power supply wiring to the card/loops, wire colors, and terminal numbers shall be shown on the wiring diagrams. The I/O cards, the loops and any device in the loop shall be shown together. Each loop shall be complete, including the source/destination within new or existing panels, device(s) in the loop, field connection panels or field junction boxes, field and PLC interface terminal blocks and wire numbers.
      - In addition wiring diagrams shall show the following details
        - Functional name of each loop
        - Reference name, drawing, and loop diagram numbers for any signal continuing off the wiring diagram sheet.
        - MCC panel, circuit, and breaker numbers for power feeds to the loops and instrumentation.
        - Wiring type, size and color
        - Designation, and if applicable, terminal assignments associated with every manhole, pull box, junction box, conduit in which wiring is to be located, and panel through which the loop circuits pass.

        - Vendor panel, instrument panel, conduit, junction boxes, equipment and PLC terminations, termination identification wire numbers and colors, power circuits, and ground identifications.
    - Wiring diagrams shall be developed for loops in equipment vendor-supplied packages, equipment provided under Division 17, and OWNER-furnished equipment.

b. Panel Wiring Diagrams: Panel wiring and/or piping diagrams shall be prepared in concert with the PWWD and shall include the following information:
    - Name of panel
    - Power distribution schematic diagrams associated with each panel or system (120VAC, 24VDC and other DC systems, control circuits). The schematic diagram shall show source of power for the panel (circuit breaker panel and breaker) and fuses. All power backup system distribution shall also be shown.
    - Schematic diagrams for control circuits in accordance with ANSI standards. The diagrams shall show complete details on the circuit interrelationship of all devices within and outside each Control Panel. Including primary measurement and control devices.
    - Communication diagram(s) for the equipment inside the panel.
    - Interfaces with existing control and monitoring systems. The CONTRACTOR shall furnish all necessary diagrams that depict any and all modifications made to existing measurement and control circuits, equipment and wiring. It is the responsibility of the System Supplier to ascertain actual field conditions of the existing circuits, equipment and wiring. The CONTRACTOR may request copies of as built drawings and data that the OWNER can provide that show such existing conditions. Lack of such drawings shall not alleviate the contractual responsibility to ascertain and implement interfaces and modifications to existing measurement and control circuits, equipment and wiring.
    - Surge protection and signal and safety grounding circuits
    - Wiring type and piping size and material
    - Terminal block numbers and wire numbers

c. Panel Drawings: Panel drawings, including console, and cabinet layout drawings, shall be prepared and submitted for each panel and shall include the following information: These drawings shall include enough other details to define exactly the style, the contents, and overall appearance of the panel assembly.
    - Name of Panel.
    - Panel Dimensions; front, side, and plan views and layout to scale.
    - Arrangement of internally and externally mounted instruments and equipment to scale. Note: Control panel layouts shown on the Contract Drawings are diagrammatic.
    - Location of terminal blocks, electrical devices, and conduit entry location(s).
    - Tag number or item number and functional name of items mounted in and on panel, console, or cabinet.
    - Nameplate legend which includes text, letter size, and colors to be used.
    - Complete and detailed Bills of Materials shall include all items within a panel and shall be presented on the panel layout drawing. The bill of material list shall include quantity, description, manufacturer, and part number.
    - Panel mounting information, including conduit entrance location.

- Communication hardware installation, such as radio, mast and antenna.
- Assembly and construction drawings. These drawings shall include dimensions, identification of all components, construction material and gauge, surface preparation and finish data, panel door locks and hinge mechanism, nameplates, and the like.

J. Factory Test Procedure Submittal:

1. Submittal Schedule: The CONTRACTOR shall submit for approval a comprehensive factory acceptance test (FAT) procedure **complete within** 180 **calendar days** after the date of Notice to Proceed is given to the CONTRACTOR, but not later than 60 **calendar days** prior to the Factory Acceptance Test date.
2. Submittal Contents:
   a. The CONTRACTOR shall develop and submit a factory test procedures to show that the integrated system hardware and software is fully operational and in compliance with the requirements of the Contract Documents.
   b. The FAT procedures shall include the following tests to be conducted:
      - Hardware review and inventory
      - Central computer system(s) start-up
      - Security
      - Navigation and operator's commands
      - Database definition and configuration
      - Graphic displays and editing function
      - Monitoring and alarm features and functions
      - Trending functions
      - Reports and report system functions
      - Redundancy and backup
      - Network Communication and access from all the network nodes
      - Remote access from laptops
      - PLC functionality – I/O processing
      - Site/facility/Process PLC and HMI operation including pump and valve control
   c. Procedure Format: The test procedure shall have a table of contents and each procedure shall be provided on a separate sheet or sheets. The following shall be provided for each procedure:
      - Test number
      - The purpose of the test
      - The procedure
      - The expected result
      - Space to indicate "Pass" and "Fail" and explanation
      - Space for sign-off Signature for the Contractor/System Supplier, the ENGINEER, the OWNER, and DATE
      - Space to provide comments and punch list items

1.07 CLOSEOUT SUBMITTALS

A. In addition to the requirements specified in Division 01, provide the following information:

1. Information in the Technical Manual shall be based upon the approved Shop Drawing submittals as modified for conditions encountered in the field during the WORK. The Technical Manuals shall therefore contain the as-built drawings and information.
2. The Technical Manuals shall include installation, connection, operating, calibration, set points (e.g., pressure, pump control, time delays, etc.) adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.
3. The Manuals shall have the following material organized in volumes and divided by subject and tabs The Technical Manual shall have the following organization for each process (the number and the enumeration of the sections shall be project specific):
    a. Section A - Process and Instrumentation Diagrams (as built copy)
    b. Section B - System Architecture and Communication System Block Diagram(s)
    c. Section C - Wiring Diagrams. A separate set of drawings shall be provided for each site. Each set shall be arranged in a separate tab (drawings shall also be provided in PDF).
    d. Section D – Functional design report. It shall include a copy of the site graphic display(s) and description how the site is controlled and any special control strategies specific for each site. Special control functions in the server shall also be included. Calibration, set points (e.g., pressure, pump control, time delays, etc.) shall also be included.
    e. Section E - Instrument Data Sheets and corresponding manufacturer's data sheet/catalog cuts/brochure that was used in the hardware submittal and the operation and maintenance/user manual.
    f. Section F - Calibration Documentation
    g. Section G – Communication survey and test results
    h. Section H - Loop, Commissioning and Performance Test Results

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. The CONTRACTOR shall provide the specified spare parts and tools. In addition, The ENGINEER and the OWNER will select from the priced list of "Additional Recommended Spare Parts" in the Hardware Equipment Submittal. The CONTRACTOR shall furnish these parts and will be paid for them from the corresponding allowance item in the Bid. The total price will not exceed the amount of the allowance item.

B. The CONTRACTOR shall furnish a priced list of special tools required to calibrate and maintain the instrumentation provided from which the ENGINEER or the OWNER will select the needed tools. After approval the CONTRACTOR shall furnish tools on that list. The cost of these tools will be included in the allowance.

1.09 COORDINATION

A. The CONTRACTOR shall coordinate all network, SCADA, and control-system integration activities with the City Programmer. This coordination shall include verification of communication requirements, network topology, security policies, and integration of new equipment into existing controls and monitoring infrastructure.
    1. The CONTRACTOR shall coordinate with the City to obtain approved IP addresses, subnet assignments, VLAN information, and communication parameters for all new networked equipment.

B. The CONTRACTOR shall examine the drawings and specifications of each division associated with this work. Before commencing work, obtain a ruling from the ENGINEER any conflicts between divisions.

C. The drawings and specifications shall be read and interpreted in conjunction with other Divisions.

D. The responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

E. Provide work plan and identify methodologies for equipment installation with provision made for the most expeditious means to complete the work.

F. Treat any item or subject omitted from this Division's specifications, but which is mentioned or reasonably specified in other Divisions' specifications or drawings and pertains to the instrumentation and control system, as being integral to the overall system. Provide such specified items or subjects.

G. Structural members shall not be cut without prior approval of the ENGINEER.

H. The Contractor is responsible to coordinate their work with other trades, and the OWNER'S Representative.

I. The Contractor is responsible for determining cable lengths for manufacturer supplied equipment and devices with integrated cables.

1.10 QUALITY ASSURANCE

A. Factory Acceptance Tests (FAT)

1. Prior to shipment, the I&CS including all panels, integrated SCADA system, PLCs, peripherals, communications equipment, etc. provided under this Division, shall be assembled, connected, and all software loaded for a full functional factory acceptance test (FAT) of the integrated system. Existing equipment is not required to be included in this test.

2. In preparation for the FAT, the CONTRACTOR shall check, troubleshoot, debug and test the I&CS prior to arrival of the ENGINEER in order for the I&CS to be ready for the FAT, minimize testing time, and minimize re-testing during the visit. Similar testing shall be performed even if the ENGINEER chooses not to witness the FAT.

3. The CONTRACTOR shall allow the ENGINEER and OWNER to inspect the I&CS and witness the functional testing of the system at the site of assembly and integration of the system.

4. A minimum of 21 Days notification shall be given to the ENGINEER prior to testing. No shipments shall be made without the ENGINEER's approval. A successful completion of the test is a prerequisite to the shipment of the system.

5. The factory test will be witnessed by the ENGINEER and the OWNER. The CONTRACTOR shall pay and provide for travel, food, and lodging for all the test witnesses.

6. The factory acceptance test shall be conducted at the place where the system was engineered, fabricated, assembled, and programmed.

7. It is considered reasonable that once scheduled, the system will be ready for the test and the test will be successfully completed in one session. If during the test, at the opinion of the ENGINEER and in accordance with the test procedure, the system is not ready for the test or has failed, and the ENGINEER and the OWNER must extend their stay or leave and arrive at another date, the OWNER reserves the right to withhold monies due to the CONTRACTOR to cover additional costs of the ENGINEER's time, travel, food, and lodging and associated project cost.

8. During the factory acceptance test, the CONTRACTOR's Project Manager and software engineers (HMI application software and PLC programming) who worked on the I&CS shall be available on the premises where the test is being conducted for explanation, demonstration or corrections.

9. After the successful completion of the test, the ENGINEER will generate a punch list. The list may include items that must be corrected or addressed prior to the shipment of the system, and/or items that must be corrected later in the field during installation and startup.

B. Field Tests: The CONTRACTOR's attention is directed to the Article "EXECUTION" of this Section which delineates all the tests that are required to be performed in the field in order to demonstrate compliance with the Contract Documents.

C. The CONTRACTOR shall provide and assign to the OWNER all user software and hardware licenses. Computer and software system shall be purchased on behalf of the OWNER who shall also be designated as the licensee. Each software package shall be provided with a “Site License” or with as many licenses as a “Site License” includes (site is defined as the name of the OWNER). The CONTRACTOR shall include in the bid price all license fees.

D. The CONTRACTOR shall provide the proper number of software licenses for all the servers, workstations, and laptops to provide concurrent and simultaneous user operation.

E. Prior to final acceptance of the I&CS System and related equipment, the CONTRACTOR shall propose and present in writing to the OWNER a one-year maintenance contract and quotation which will become effective upon the expiration of the warranty. The maintenance contract is an option that the OWNER may purchase from the System Supplier. The contract shall offer different maintenance, site visit and help-desk with options each with its respective cost.

1.11 FIELD SITE CONDITIONS

A. The I&CS shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:

1. Sewer Pump Stations

B. Site Equipment:

C. Ambient temperature range: -18° through 60° C

D. Thermal shock: 1.0° (1.8° F) per minute maximum

E. Relative humidity: 95 percent maximum non-condensing.

F. Unless specified otherwise, provide equipment and instrumentation suitable for continuous operation at an elevation of 5000 feet above sea level.

G. Classification of Plant Areas.

1. Refer to Division 16.

1.12 WARRANTY

A. All parts, material labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period shall be borne by the CONTRACTOR under the guarantee specified in Division 1. Equipment, software, and materials that do not achieve their intended purpose shall be replaced by the CONTRACTOR to attain compliance, at no additional cost to the OWNER.

B. The performance of the servers and workstations hardware shall be guaranteed (repair of parts and labor at the owner's site including travel expenses) for a period of three (3) years following the date of completion and formal acceptance of the work (next business day on-site service).

C. Software Upgrades: During the warrantee period, the CONTRACTOR shall furnish and install at no additional cost to the OWNER any application software upgrades published applicable to OWNER’s applications and compatible with OWNER’s hardware and operating system.

PART 2 - PRODUCTS

2.01 GENERAL

A. Standard and Current Technology: All I&CS hardware, software, materials, and equipment furnished under this contract shall be new, free from defects, and shall be standard products and

technology produced by manufacturers regularly engaged in the manufacturer of these products. Meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

B. The CONTRACTOR shall submit a Substitute Item Request Form in case of discontinued or upgraded product or other cases where changing technology requires changes in equipment or software.

C. Adverse Environmental Impact: No component of an instrumentation system shall contain liquid mercury.

D. Hardware Commonality and Modularity: Instruments which utilize a common measurement principle shall be furnished by a single manufacturer. Panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single manufacturer. All equipment shall be of modular design to facilitate interchangeability of parts to assure ease of servicing and expandability.

E. Instrument and Loop Power: Power requirements and input/output connections for components shall be verified. Power for transmitted signals shall, in general, originate in and be supplied by the control panel devices. The use of "2 wire" transmitters is preferred, and use of "4 wire" transmitters shall be minimized. Individual loop or redundant power supplies shall be provided as specified and/or as required by the manufacturer's instrument load characteristics to ensure sufficient power to each loop component. Power supplies shall be mounted within control panels or in the field at the point of application.

F. Loop Isolators and Converters: The CONTRACTOR is responsible to resolve any signal level incompatibilities where required.

G. Signal Levels: Analog measurements and control signals shall be as indicated herein, and unless otherwise indicated, shall vary in direct linear proportion to the measured variable. Electrical signals outside control panels shall be 4 to 20 milliamperes DC except as indicated. Signals within enclosures may be 1 to 5 volts DC. Electric signals shall be electrically or optically isolated from other signals. Pneumatic signals shall be 3 to 15 psig with 3 psig equal to 0 percent and 15 psig equal to 100 percent.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Refer to the requirements of Division 01 for additional requirements.

B. Shipping

1. After completion of shop assembly, factory test, and approval, the tested I&CS equipment, cabinets, panels, and computer hardware shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.

C. Special Instructions

1. Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

D. Tagging

1. A permanent stainless steel or other non-corrosive material tag marked with the instrument or equipment tag number shall be provided on each piece of equipment in the I&CS. Identification shall be prominently displayed on the outside of the package.

E. Storage

1. It is the CONTRACTOR's responsibility to assure proper handling and on-site storage of instrumentation and control equipment in accordance with the System Supplier's recommendations. All equipment and materials delivered to the jobsite shall be stored in a location which will not interfere with the operations of other contractors or the OWNER. Equipment shall not be stored outdoors. Storage and handling will be performed in manners which will afford maximum protection to the equipment and materials.
2. Equipment shall be stored in dry shelters, including in-line equipment, and shall be adequately protected against mechanical damage. If any apparatus has been damaged, such damage shall be repaired by the CONTRACTOR. If any apparatus has been subject to possible damage by water, it shall be thoroughly dried out and put through tests as directed by the ENGINEER. If such tests reveal defects, the equipment shall be replaced.

3.02 PRODUCT HANDLING

A. Use all means necessary to protect the installation and to protect products and installed work of all other trades.

B. Any damage to the products and/or installed work shall be repaired or replaced by the contractor, to the satisfaction of the OWNER and ENGINEER, at no additional cost to the OWNER.

3.03 INSTALLATION

A. All systems and instrumentation, including instrumentation furnished under other Divisions, shall be installed, connected calibrated, tested, started, and placed into operation in accordance with CONTRACT documents under Division 17 and the manufacturers' instructions. The installation shall be coordinated with the ENGINEER and the OWNER. This shall include final integration in concert with equipment specified and provided by others.

B. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all I&CS equipment.

C. Equipment Locations: The monitoring and control system configurations indicated in the contract documents are diagrammatic. The locations of equipment are approximate unless dimensioned. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the OWNER exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the CONTRACTOR shall make such changes without additional cost to the OWNER.

D. The CONTRACTOR shall review the existing site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

E. The Contract Documents identify conduits and instruments required to make a complete I&CS. The CONTRACTOR shall be responsible for providing any reasonable additional or different type connections as required by parts of the I&CS' specific installation requirements, or as practical.

3.04 CONDUIT, CABLES, AND FIELD WIRING

A. Conduits, process equipment control wiring, 4 to 20 mA signal circuits, signal wiring to field instruments and to control panels, PLC input and output wiring, and other field wiring and cables shall be provided under Division 16 and without delay to the WORK of Division 17.

B. PLC equipment cables shall be provided under Division 17, but the installation in the field shall be under Division 16.

C. Terminations and wire identification inside I&CS equipment and panels furnished under this or any other Division shall be provided under Division 17.

D. The CONTRACTOR shall supervise and coordinate installation and termination and identification of field signals, power, and utilities associated with the I&CS. Resolve signal, power, or functional incompatibilities between the I&CS and new and existing interfacing devices.

3.05 EQUIPMENT CONNECTIONS AND INSTALLATIONS

A. Instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements applicable to the Site. Appropriate mounting stands and bracket materials and workmanship shall be provided and shall comply with requirements of the Contract Documents.

B. Existing Instruments that are to be removed and reinstalled shall be cleaned, reconditioned, and recalibrated by an authorized service facility of the instrument manufacturer. The CONTRACTOR shall provide certification of this WORK prior to reinstallation of each instrument.

C. The Contract Documents show necessary conduit and instruments required to make a complete instrumentation. The CONTRACTOR shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the ENGINEER for approval prior to commencing that WORK. Such changes shall not be a basis of claims for extra WORK or delay.

D. Field Connection Panels and Interface Terminal Blocks: In cases where field I/O wiring has to be extended to a control panel or from enclosures or devices that are removed, the CONTRACTOR shall provide separate enclosures or junction boxes with interface terminal blocks that will serve as a field connection panel (FCP). The FCP and the terminal block shall be shown on the project-wide wiring diagrams.

E. Conduits and/or raceways in building interior locations shall be surface mounted on walls or ceilings wherever possible and run perpendicular and parallel to building lines. Conduits shall not be routed on floors in areas subject to foot traffic. In exterior locations conduit shall be routed below grade.

F. Wires and cables shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the ENGINEER. Wiring shall be protected from sharp edges and corners.

G. Signal and 24VDC low voltage wiring shall be run in a separate conduit from power and 120-volt control wiring.

H. Field wiring shall terminate at terminal blocks in the control panel. Field wiring shall not be wired directly to equipment in the control panel except communication and specialty cables that must be wired directly to their respective equipment.

I. Wires shall be marked clearly with an identification wire number labels that are of a permanent nature.

J. Connectors shall be, as a minimum, water tight.

K. Flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.

L. Differential pressure elements shall have 3 valve manifolds.

M. The CONTRACTOR shall verify the correctness of each installation, including polarity of electric power and signal connections. The CONTRACTOR shall certify in writing all discrepancies have been corrected for each loop or system checked out. In addition, the CONTRACTOR shall make sure process connections are free of leaks.

N. Moisture barriers shall be provided with enclosure rated for area installation.

3.06 SEALING OF WALL AND FLOOR OPENINGS

A. The CONTRACTOR shall seal all conduit and cable entries passing through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade.

B. Sealing material shall be fire resistant and not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations, if required, are to be sealed. Acceptable methods are Canstrut "Fire Stop", Electrovert "Multi-Cable Transit" or Dow Corning RTV Silicone Foam.

C. Cable transit blocks (with knock out blocks) are also acceptable as long as they have capability to be sealed.

3.07 SLEEVES

A. Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

B. For wall, partitions and ceilings the sleeve ends are to be flush with the finish on both sides. For floors the ends shall extend 4” above finished floor level.

C. Fill the space between the sleeve and the conduit with fire stop material and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.

D. Locate the sleeves and position exactly prior to construction of the walls and floors.

E. Failure to comply with the above requirements shall be remedied at the Contractor's expense.

3.08 TAGGING STANDARDS FOR DEVICES AND WIRING

A. Tag all devices, wires and I/O using the assigned loop, equipment or device tag name. Where tag naming and numbering is not defined, the Engineer will provide naming and numbering that is consistent with the plant naming conventions.

3.09 FIELD QUALITY CONTROL

A. Devices provided under Division 17 shall be initially calibrated by the manufacturer at the manufacturer’s facility prior to shipment. Following installation, the devices shall be field calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

B. Each instrument shall be field tested, inspected, and adjusted to the indicated performance requirement in accordance its manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirement, or, in the absence of a contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the ENGINEER.

C. Calibration Points: During bench and field calibration each instrument shall be calibrated at least at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs and outputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.

D. Bench Calibration: Instruments that have been bench-calibrated by the manufacturer shall be verified in the field after installation to determine whether any of the calibrations are in need of adjustment.

E. Field Calibration: Instruments which were not bench-calibrated shall be calibrated in the field to insure proper operation in accordance with the instrument loop diagrams or specification data sheets.

F. Analyzer Calibration: Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.

G. Calibration Sheets: Each instrument calibration sheet shall provide the following information and a space for sign-off on individual items and on the completed unit:

1. Project name
2. Loop number and site or process name and number
3. Tag number
4. Manufacturer
5. Model number
6. Serial number
7. Calibration range
8. Calibration data: Input, output, and error at 0 percent, 50 percent, and 100 percent of span
9. Switch setting, contact action, and dead-band for discrete elements
10. Space for comments
11. Space for sign-off by System Supplier and when applicable by the manufacturer and date
12. Test equipment used and associated serial numbers
13. Calibration Tags: A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the ENGINEER. The CONTRACTOR shall have the System Supplier sign the calibration sheet when calibration is complete. The ENGINEER will sign the calibration sheet when the calibration and testing has been accepted.
14. Loop Testing: The Contractor shall test newly installed loops for continuity and functionality. The up-to-date wiring diagrams shall be used as reference. The ENGINEER and/or the OWNER shall witness the loop testing.

H. The CONTRACTOR shall notify the ENGINEER of scheduled tests minimum of 30 calendar days prior to the estimated completion date of installation and wiring of the I&CS. After the ENGINEER's review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop testing shall be witnessed by the ENGINEER and/or the OWNER.

I. Control Valve Tests: Control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to insure that no changes have occurred since the bench calibration.

J. Interlocks: Hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers, and packaged equipment controls shall be checked to the maximum extent possible.

K. Loop Validation:

1. Control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the HMI displays associated with the PLC or DCS. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested.

2. Accuracy tolerances for each analog network are defined as the root-mean-square (RMS) summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by contract requirements or by published manufacturer accuracy specifications, whenever contract accuracy requirements are not indicated. Each analog loop shall be tested by applying simulated analog or discrete inputs to the first element of an analog loop. For loops which incorporate analog elements, simulated sensor inputs corresponding to 0, 25, 50, 75, and 100 percent of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated RMS summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. Analog loop test data, including calculated RMS summation system accuracy tolerance, shall be documented by the CONTRACTOR on the loop validation sheets. The validation sheets shall be included in the O&M Manuals.

L. Loop Validation and Certification Sheets:

1. Loop Validation: The CONTRACTOR shall prepare loop validation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. Loop validation sheets shall form the basis for operational tests and documentation. Each loop validation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop by the System Supplier:
   a. Project name
   b. Loop number
   c. Tag number, description, manufacturer, and model number for each element
   d. Installation bulletin number
   e. Specification sheet number
   f. Loop description number
   g. Adjustment check
   h. Space for comments
   i. Space for loop sign-off by the System Supplier and date
   j. Space for ENGINEER witness signature and date
2. Loop Certification**:** A certified copy of each loop test validation sheet signed by the System Supplier, the ENGINEER or the ENGINEER's representative as a witness, with test data entered, shall be submitted to the ENGINEER together with a clear and unequivocal statement that the loops have been tested and the instrumentation in the loop has been successfully calibrated, inspected, and tested.

M. Manufacturer’s Services

1. The CONTRACTOR shall provide jobsite visits and services of a manufacturer’s technical field representative for supervision of the following:
   a. Oversee installation: Supervise installation and connection of all instruments, elements, and components of every system, including connection of instrument signals to primary measurement elements and to final control elements such as VFD, smart starters, pumps, valves, engines and chemical feeders
   b. Verify that installed instrument and software meet manufacturer’s recommendations
   c. Certify installation and reconfirm manufacturer's accuracy statement
   d. Oversee loop testing, prepare loop validation sheets, and certify loop testing
   e. Certify when testing is completed.

f. Training the OWNER's personnel

3.10 OPERATIONAL VALIDATION

A. Where feasible, system pre-commissioning activities shall include the use of the actual process to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, PLCs, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational.

B. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of process controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

C. Pre-commissioning shall also include the testing of remote sites to verify compliance with all functional requirements and communication specified. The testing shall include manual and automatic control modes, fail-safe and backup control modes, and PLC interlocks and control strategies provided by the System Supplier.

D. Loop and Equipment Tuning: Controllers incorporating proportional, integral and/or derivative control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed set point settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

E. Pre-commissioning Validation Sheets: Pre-commissioning shall be documented on test forms as follows:

F. The validation form, which shall include:

a. Project name

b. Loop number

c. Loop and function description

d. Tag number, description, manufacturer, and data sheet number for each component.

e. Pre-Commissioning Certification - A statement certifying that the contract requirements have been met. It shall also include a listing of instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system testing must be provided in writing by the ENGINEER before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the General Conditions.

f. Space for sign-off and date by the CONTRACTOR, the System Supplier, and the ENGINEER.

3.11 COMMISSIONING

A. Commissioning is the verification that the complete WORK functions on an extended basis are in full conformance with the Contract requirements.

B. As part of the commissioning, the entire I&CS shall operate continuously without failure for 30 consecutive days without failure (see test details below), thus extending its operation test longer than the commissioning period specified in Division 01.

C. Refer to the requirements of Division 01 for additional commissioning requirements.

D. The CONTRACTOR shall submit a report/letter states that CONTRACT requirements have been met and the I&CS is ready (2) weeks prior to energizing any system to allow inspections by ENGINEER.

E. The entire I&CS shall go through a final 30-day acceptance test. For the purpose of this CONTRACT, the terms “Final Acceptance Test” and “Final Performance Test” are synonymous and are used interchangeably. The 30-day test must be successfully completed prior to the date of and as a condition to substantial completion of the entire project WORK. During the testing period, all system functions shall be exercised, and any system interruption and accompanying component, subsystem, software, or program failure shall be logged for cause of failure, as well as time of occurrence and duration of each failure.

F. In addition to the requirements of Division 01, the CONTRACTOR shall furnish support staff as required to operate the system and to satisfy the repair or replacement requirements. The CONTRACTOR shall also provide a competently programmer on call during all normal working days and hours from the start of the acceptance test until final acceptance of the system. The on-call programmers shall be ready to respond within two hours of the notification of the problem.

G. Testing

1. The entire I&CS shall be tested and shall include, but not limited to the following:

a. Verify instrument calibration and provide written report.

b. Verify signal levels and wiring connections to control panels for all instrumentation and control equipment.

c. Function check and adjust under operational conditions the instruments and control equipment.

d. Coordinate instruments and control equipment supplier's service personnel as required for complete system testing.

e. The CONTRACTOR shall make provision to be available and coordinate with the Plant Control System programming team, and the commissioning team to check the sensor signals from source to destination.

f. Instruct plant personnel in correct method of operation of instruments and control equipment.

g. Direct plant personnel at hand-over as to final adjustment of the system for correct operation of plant.

H. Failure During Testing: Failure of the system during the testing shall be considered as indicating that part of the I&CS does not meet the requirements of the specifications and corrective action shall be required before restarting the acceptance test.

I. Technician Report: Each time a technician is required to respond to a malfunction in the I&CS he/she must complete a report which shall include details concerning the nature of the complaint or malfunction and the resulting repair action required and taken. If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report shall be required (logged as specified above). Each report shall be submitted within 24 hours to the ENGINEER or its representative, and the OWNER.

3.12 TRAINING

A. The CONTRACTOR shall train the OWNER'S personnel on the I&CS operation, maintenance, calibration, and repair of equipment provided under this Contract. The training shall be by

qualified instructors. The training courses shall be given on-site to a minimum of Four (4) people of the OWNER's personnel. All instruction, tools and training material shall be provided by the CONTRACTOR.

B. These courses shall be designed to provide the operations, maintenance and supervisory personnel with training in routine and preventive maintenance of all the I&CS including instrumentation, communication, PLCs software, and HMI. The training course shall include instruction on the use of all maintenance equipment and special tools provided under the contract.

C. Instructions

1. The training shall be performed by qualified instructors. The training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

D. Training Manuals and Material

1. The CONTRACTOR shall use the approved Training syllabus and Training Manuals to develop training material. The training material shall be designed to provide the operations, maintenance and supervisory personnel with training in routine operation procedures, and preventive maintenance and troubleshooting of the I&CS, PLCs and the computer monitoring and control systems.

E. Schedule

1. Training shall be performed on-site during the calibration, loop and functional testing of the I&CS prior to the 30-day Final Acceptance Test. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The ENGINEER will review the course outline for suitability and provide comments that shall be incorporated. Due to availability and scheduling of the OWNER's staff, the CONTRACTOR shall coordinate with the OWNER the schedule of the classes. The OWNER reserves the right to videotape the training sessions for later use. Due to possible limited availability of the OWNER's staff, the CONTRACTOR shall provide the number of identical courses/sessions of each of the following training courses as indicated, each up to four (4) people of the OWNER's staff.

F. Training Subjects, Duration, and Agenda**:** The training shall include operation and maintenance procedures, troubleshooting with necessary test equipment, and changing set points, and calibration for that specific piece of equipment. During the course, hands-on experience with the system equipment shall be provided. Maintenance classes shall stress troubleshooting, repair, calibration, and other technical aspects of the I&CS and the PLCs. Operator classes shall stress operational theory and use of the I&CS and the PLCs.

1. Field Instruments

a. Duration – an average of one (1) hour per each type of instrument

b. Subjects - installation, setup, configuration, maintenance, calibration, and troubleshooting:

- Pressure transmitter
- Level transmitter
- Flow measuring device and transmitter
- Power monitoring equipment
- Uninterruptible power supply (UPS)

END OF SECTION

SECTION 17110
CONTROL PANEL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR through the System Supplier shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install control panels for the PLC-based control system, complete and operable, in accordance with the Contract Documents.

B. The system Supplier shall be responsible for selecting, sizing, and providing the required type and quantity of the panels for each process control applications. The hardware and responsibilities shall include but not limited to:

1. The selection of all accessories, materials and methods of fabrication not specifically covered by these specifications, but which are necessary to complete the fabrication of the panels. Installation of all equipment shall be performed in accordance with good engineering and industry best practices.
2. Mounting enclosures.
3. Locating and mounting interior/exterior instrumentation, hardware and equipment in the control panel.
4. Field interface terminal blocks
5. Terminating panel internal wiring and signals.
6. Terminating communication and network cabling and wiring.

C. The requirements of Section 16050 – General Electrical Work, apply to the WORK of this Section

1.02 RELATED WORK

A. Division 16 Electrical Specifications

B. Section 17010 Instrumentation and Control for Process Systems

C. Section 17710 PLC-Based Control System Hardware

D. All electrical work required under this section shall conform to the requirements of Division 17 and the applicable requirements of Division 01, Division 16.

1.03 REFERENCE CODES AND STANDARDS

A. Reference Standards:

1. NFPA 70, National Electric Code
2. ANSI/UL 1449, Fourth Edition, Safety Surge Protective Devices
3. IEEE C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits
4. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connect to Low-Voltage (1000V and Less) AC Power Circuits
5. UL 1283, Safety Electromagnetic Interference Filters
6. NFPA 70, National Electric Code
7. National Standards Institute (ANSI) / Institute of Electrical and Electronic Engineers (IEEE):
    a. C62.90.2, IEEE trial use standard withstand capability of relay systems to radiated electromagnetic interference from transceivers.
    b. C62.41, IEEE recommended practice on surge voltages in low-voltage AC power circuits.
    c. C62.45, IEEE guide on surge testing for equipment connected to low-voltage AC power circuits.
8. Underwriters Laboratories, Inc. (UL):

a. UL 508, Industrial control panels.

b. UL 1283, Safety-electromagnetic interference filters.

c. UL 1449, Surge protective devices.

9. Electronic Industries Association (EIA):

a. TIA-232-E, interface between data terminal equipment and data circuit-terminating equipment employing serial binary data interchange.

b. 422-A, electrical characteristics of balanced voltage digital interface circuits.

10. International Organization for Standardization (ISO) 9001, quality systems-model for quality assurance in design, development, production, installation, and servicing.

11. National Electrical Manufacturers Association (NEMA):

a. ICS 1 - General Standards for Industrial Control and Systems.

b. ICS 3 - Industrial Systems.

c. ICS 4 - Terminal Blocks for Industrial Use.

d. ICS 6 - Enclosures for Industrial Controls and Systems.

e. LS1 - Low Voltage Surge Protection Devices.

f. Publication No. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

g. NEMA IA 2.2 - Programmable Controllers - Equipment Requirements and Tests.

h. NEMA IA 2.3 - Programmable Controllers - Programming Languages.

i. NEMA ICS 3 - Industrial Control and Systems: Factory Built Assemblies.

j. NEMA ICS 6 - Industrial Control and Systems: Enclosures.

12. National Fire Protection Association (NFPA).

13. Each control panel, including panels for service entrance equipment, shall meet all UL listing and labeling requirements including UL Standard 508 and UL Standard 508A and shall be UL labeled accordingly.

1.04 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals and 17010 - Instrumentation and Control for Process Systems.

B. Control panels, wall mounted and free-standing, shall be provided with mounting and anchoring calculations signed by a California Registered Structural Engineer.

1.05 QUALITY ASSURANCE

A. Factory and field tests shall be performed in accordance with 17010 - Instrumentation and Control for Process Systems.

1.06 SPARE PARTS

A. (2) Power Supply

B. (1) Redundant Power Supply Module

PART 2 - PRODUCTS

2.01 GENERAL

A. All control panel assemblies for PLC’s, Remote I/O, analyzer systems, communication systems, etc., shall be mounted within NEMA-rated enclosure suitable and designed for the process application, as specified in the Contract Drawings.

B. Reference Contract Drawings for control panel layouts and product requirements. The control panel layouts shown on the Contract Drawings are diagrammatic. The control panel submittal shop

drawing shall reflect the accurate layout of the equipment in the panel. It is not the intent of this specification to completely specify all details of the design and construction of each panel.

C. Control panels shall be either freestanding, pedestal-mounted or equipment skid-mounted.

D. The enclosures shall be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any distortion or warping. The CONTRACTOR shall supply all equipment and components mounted on or within panels unless otherwise noted. Spare space shall be kept clear of wiring, etc., to give contiguous clear space for future additions.

E. When required, PLC-based control system panel assemblies shall be mounted in existing enclosures.

1. The CONTRACTOR shall review the available space in the field or in the existing panel to determine the proper size of back panel suitable to accommodate the required equipment for the facility.

F. Environmental Suitability and NEMA Rating:

1. Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents.

2. Provide heating, cooling, and dehumidifying equipment required to maintain instrumentation devices 20-percent within the minimums and maximums of their rated environmental operating ranges. Provide power wiring for these heating, cooling and dehumidifying devices.

3. . Enclosures shall be suitable for the environment that they are installed. Panel instruments and equipment in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

4. Control panels shall be sized to adequately dissipate heat generated by equipment mounted in or on the panel.

5. Enclosure Ratings:

a. NEMA 12: Suitable for enclosures located in the, Electrical Room, and Control Room.

b. NEMA 4X: Suitable for enclosures located outdoors and in damp and corrosive process areas.

c. NEMA 7X (explosion proof and corrosion resistant): Suitable for enclosures located in classified areas.

d. ALL modifications to the panel enclosure including device penetrations shall not compromise the enclosure rating.

2.02 ENCLOSURE CONTRUCTION

A. Approved enclosure manufacturers

1. Hoffman

2. Ritta

3. Eletromate

4. Or approved equal.

B. Material and Fabrication

1. Floor mounted free-standing enclosures shall be made of 12-gauge, depending of the size of the enclosure, application, and the project requirements.

2. Seams shall be continuously welded and ground smooth. Corners shall be welded and ground smooth.

3. Each enclosure shall have a heavy gauge, continuous piano hinge pin which shall support each door.

4. Door and body stiffeners shall be provided where required. The stiffeners shall be welded to the inside of enclosures to prevent deformation due to the weight of face-mounted instruments.
5. Doors shall be sealed with a closed cell neoprene gasket.
6. The interior rear and sides of each enclosure shall have steel mounting channels for supporting mounting panels.
7. Enclosures shall be provided with external mounting feet when shown, as well as door clamps, hasp and staple for padlocking, data pocket, and closed-cell oil-resistant gasket. Removable lifting lugs to facilitate handling shall be provided on large enclosures.

C. Back and Side Panels

1. Each enclosure shall be provided with a removable back panel. Depending on the size of the enclosure more than one back panel may be required. Removable side panels shall be provided as required for additional mounting space.

D. Control Panel Finish

1. Non-stainless-steel enclosures shall have an ANSI 61 gray polyester urethane powder coating electrostatically applied to inside and outside surfaces. Enclosure interior, and back and side panels shall be white.
2. Stainless Steel enclosures shall be Type 316 and have a brush finish.

E. Ventilation, Louvers, and Vents

1. All enclosures rated NEMA 12 shall be provided with ventilation louvers, exhaust fan and thermostat. The perimeters of the louver plate shall be sealed with a gasket. Louver shall be of the same material and finish as the enclosure. The louver shall be sized for effective heat rejection.
2. All Control Panels installed outside or inside non-air-conditioned environments shall have an integral heater c/w thermostat.
3. All enclosures shall be provided with a corrosion inhibitor size per manufacture recommendations.
4. Each panel enclosure shall be provided with a data pocket for storing wiring diagrams, operation manuals and other documentation inside the enclosure.

F. Air Conditioning

1. NEMA 4X enclosures and enclosures with VFD’s shall be provide with Air Conditioning Units, size as recommended by the manufacturer to accommodate for heat dissipated by electrical equipment.

G. Accessories

1. The CONTRACTOR shall provide additional panel accessories to meet the specifications, such as floor stand and mounting kits, door handle and lock kits (common key shall be provided for all doors), 3-point latch, etc. Provide panels with front access only. Doors shall be key/pad lockable (as required) and fitted with 3-point heavy duty latching assemblies.

H. Instruments Mounting

1. Equipment mounted at the rear of enclosure shall be installed to allow for commissioning adjustments, operation and servicing requirements. The CONTRACTOR shall arrange components and wiring to meet UL requirements.
2. Spare space shall be kept clear of wiring, etc., to give maximum space for future additions.
3. For front mounted hardware, cutouts and holes may be cut or drilled by any standard method that does not cause deformation. Burrs shall be ground smooth. Mounting the instruments shall not degrade the NEMA rating of the enclosure.

4. Each enclosure shall be provided with interior nameplates to identify equipment tags and functions.

2.03 ELECTRICAL REQUIREMENTS

A. The main power supply to the control panel controls shall be 120 VAC, 60 Hz. The CONTRACTOR shall provide the main power supply from an external source. The CONTRACTOR shall provide a step-down transformer as required to power the panel.

B. Each source of foreign voltage shall be isolated by providing disconnect type terminal blocks Weidler or approved equal.

C. The CONTRACTOR shall provide wireways, wire, and electrical fittings and components for 120V and 24VDC circuits to instruments and other electrical devices in the panel for a complete and operable installation. Wiring methods and materials for all panels shall be in accordance with the NEC requirements.

D. The circuits for 24VDC shall run in separate wireways from the 120 VAC circuits.

E. If required by the contract documents, the control panel shall be the source of power for any 120 VAC solenoid valves interconnected with the control panel.

F. Wiring and Accessories

1. Run all wiring in enclosed plastic wireways such as Panduit. Size all wireways so that the total cross-sectional area of the insulated wire and cable does not exceed forty (40%) percent of the cross-sectional area of the wireway.
2. Provide a minimum clearance of 1.5” between wireways and any point of wire termination.
3. Control wiring to be a minimum of #14 AWG tinned stranded copper; insulation rated at 600V.
4. Wiring for power distribution shall be a minimum of #12 AWG tinned stranded copper; insulation rated at 600 V.
5. Analog wiring to be a minimum of #16 single pair copper 300V CIC white/black cable with overall foil shield and the drain wire. The black wire shall be positive and white wire shall be negative. Drain wires shall be clipped in the field and terminated on individual green/yellow terminal blocks in the control panel. The shield shall be grounded at only one end in the control panel grounding terminals, and cut back and insulated at the instrument end.
6. Cable routing and requirements shall be installed in accordance with Division [16] [26] – Electrical Specifications.
7. All wiring entering or leaving the enclosure shall be labeled with permanent marking identification subject to the review by the Engineer.

G. Terminal Blocks

1. The control panel shall be provided with sufficient terminal blocks for the connection of external field conductors, signals, and power and for use inside the panel for power distribution and for future expansion. In order to facilitate easy and safe loop maintenance, each analog input loop shall have a disconnect with test plugs built into its field terminal block.
2. Spare Terminal Blocks for Signals: The CONTRACTOR shall provide sufficient spare terminal blocks to connect additional signals for future use (implemented and future spares). Implemented spare signals shall be wired to terminal blocks and the percent of these terminals shall be in accordance with the growth requirements specified in Section [17XXX] [409510] – PLC-Based Control System Hardware. For future signals (i.e. the source of inputs or final control elements are not yet known or available in the field), the CONTRACTOR shall provide 25-percent spare terminals in the panel for each type of actual I/O in the PLC. The number of terminals shall take in account the types of I/O for which spares are provided (Three (3) terminal for each AI or AO shall be provided).

3. Spare Terminal Blocks for Power and Other Applications: In addition to the spare terminals for signals, The CONTRACTOR shall provide spare terminals for 3 additional power distribution and grounding applications circuits.

4. Terminal blocks for all wiring shall be modular terminals, DIN rail mounted strap screw type rated at 15 amperes at 600VAC and suitable for No. 12 AWG. stranded wire.

5. Identify each terminal block within an enclosure with a unique machine printed terminal block number. Cabinet chassis grounding terminal blocks to be identified by the electrical ground symbol.

6. Connections to screw terminals to be locking fork tongue insulated crimp type wire connectors equal to Panduit PAN-TERM series or T&B STA-KON series.

7. Terminals to be Weidmuller terminal blocks or engineer approved equal.

   a. WDU4 Feed through Terminal Block.

   b. WPE4 Ground Block.

   c. WTR4 Disconnect terminal.

   d. WDK4N Two Level Terminal Block.

   e. WTR 4/SI LED Fused Terminal Block - for 24 V DC rated circuits c/w all required fuses.

   f. WTR 6/2 SI LED Fused Terminal Block - for 120 V AC rated circuits c/w all required fuses.

   g. WAP End Bracket.

8. Provide a group of terminals for each of 120 V AC hot and neutral and 24 V DC positive and negative power. Distribution wiring to have a thermal magnetic circuit breaker upstream of all major blocks of loads, adequately sized to protect the connected load while not causing nuisance tripping. Provide nickel-plated terminals for all high-capacity applications in excess of 15 A.

9. Provide Weidmuller disconnect type terminal blocks c/w fuses for each load or loop powered instrument from the control panels.

H. Electrical Hardware Accessories: The control panel shall be equipped with minimum provisions listed below:

1. Duplex 15-amp, 120 VAC GCFI type receptacles for service and maintenance use. The receptacle shall be 2-pole, 3-wire grounding, and heavy-duty industrial grade by Hubbell, Leviton, or approved equal.

2. Simplex 15-amp 120 VAC GCFI type receptacle dedicated for a powering an uninterruptible power supply (UPS). The receptacle shall be color coded, 2-pole, 3-wire grounding, heavy duty industrial grade by Hubbell, Leviton, or approved equal.

3. A 120 VAC LED light strip lamp with guards and a toggle switch (Hoffman Panelite LED Series, or approved equal) mounted on the top of the enclosure or on the part the side or back panel shall be provided for panel lighting. A separate fuse/circuit breaker shall be provided for the lamp mounted inside and in the top of the back-of-panel area. Provide (2) two lamps for Control Panels that are longer than 72-inches

4. A one (1)-inch by eight (8)-inch copper grounding bus mounted in each Control Panel including grounding lugs, suitable for termination of up to #2 AWG copper grounding conductor. The grounded bus shall be bonded to the ground.

   a. The grounding bus shall be complete with solderless connector for one 2 AWG bare stranded copper cable and with tapped holes to accommodate ground connections from various devices in the enclosure.

   b. Provide ground connections for different AWG wires and shield connection clamps by Phoenix Contact, or approved equal.

c. Provide separate ground buses for analog and discrete/digital signals. The copper cable shall be provided by the CONTRACTOR and be connected to a system ground loop.

d. Bond each enclosure door to the grounding lug.

5. Provide Hoffman 120 VAC Heater and thermostat. Heater shall be DAH1001A and thermostat shall be Stego model KTO-011, or approved equal, if required.

6. Provide ventilation system sized for heat dissipation. The ventilation system shall be by Hoffman, Cooling kit with removable filter or approved equal.

I. Circuit Breakers, Fuses, and Disconnects

1. Provide circuit breakers, fuses and disconnects installed in the control panel to protect against fault current the 120 VAC and 24 VDC branch circuits. Circuit breakers shall be installed as disconnects of external power feeds for control circuits from outside the enclosure and branch circuits within the enclosure.

2. The circuit breakers, fuses and disconnects shall also allow disconnecting the power from these instruments in a safe manner. Each circuit breaker and fuse shall be clearly identified by a unique service nametag.

3. The fuses shall be DIN rail mounted with fuse holder terminal block and shall have a blown fuse indicator light.

a. The fuse holders for 120 VAC applications shall have a neon light indicator. Provide Entrelec part number 0115-661.21, or equal.

b. The fuse holders for 24 VDC applications shall have an LED indicator light. Provide Entrelec part number 0115-663.23, or equal.

4. The circuit breakers shall be DIN rail mounted type. The 120 VAC breakers shall by Square D model QUO-120 and QUO-115, amperage rating as required, or approved equal.

a. 20-Amp main circuit breaker for the 120 VAC control panel power supply and the distribution of the power.

b. 15-Amp circuit breaker for the duplex 15-amp, 120 VAC GCFI type receptacle for service and maintenance, and the LED light.

c. 15-Amp circuit breaker (or as required by the UPS manufacturer) for the dedicated simplex GCFI type receptacle for UPS.

d. 15-Amp circuit breaker for the heater and thermostat and ventilation fan.

e. 5-Amp fuse, 120 VAC for each of the 120 VAC power input circuits to the two(2) redundant 24 VDC power supplies

J. Uninterrupted Power Supply

1. The CONTRACTOR shall provide an uninterruptible AC power supply (UPS) system for each control panel to back up the power for the panel in case utility power fails. The UPS shall be a “smart” type, use on-line, high frequency, double-conversion technology. The batteries shall be integral to the UPS enclosure.

2. Capacity and Duration

a. The continuous output capacity of the UPS shall be at least 1,000 VA. It shall be sufficient to supply the computers, interface and peripheral equipment (present and future) with regulated AC power for a minimum of thirty (30) minutes from batteries only. Additional batteries or larger UPS size shall be provided to meet the specified backup time.

3. The CONTRACTOR shall submit load calculations and size each UPS to justify the selection of present and future load requirements, as well as overload and inrush capacity requirements.

4. Features and Options

a. Input Power Range: 120 VAC, 60 Hertz ± 5 Hertz.

b. Output Power Range: 120 VAC, ± 3 percent of nominal, 60 Hertz ± 0.5 percent.

c. Output Receptacles: Minimum of six (6) built-in outlets.

d. Overload Capacity: The UPS shall have the ability to supply 110 percent of system requirements for 10 seconds, without degradation of the service life.

e. Operating Temperature: 0-to-40-degree C.

f. Protection: The UPS output shall be protected (IEEE standards) from lightning, surges overload, and short circuit. The input shall be protected by a circuit breaker, sized in accordance with manufacturer's recommendations.

g. Battery: Lead acid type, maintenance free, sealed suspended electrolyte, and leak-proof. Recharge Time (with half load): three (3) hours.

h. Alarms and Status: The UPS shall be provided with a relay output card in a combination with a network management card (NMC) to provide a common dry contact output that represents the health/status of the UPS and battery functions (i.e. low battery, UPS on batteries, UPS fault, batteries failed on battery self-test). The NMC shall be configured to provide the above alarms/status listed above.

5. Manufacturer: Schneider Electric APC model Smart-UPS with communication and relay interface cards, or approved equal.

K. 24VDC Power Supplies

1. Control panels shall be provided with redundant power supplies which shall be configured in a fault-tolerant manner to prevent interruption of service upon failure and interruption of service necessitated by the replacement of a power supply.

2. The CONTRACTOR shall size the power supplies to meet the control panel requirement and the instruments and loops they support. Power supplies shall have an excess rated capacity of 40 percent. The failure of a power supply shall be alarmed at the SCADA System.

3. The failure of a power supply shall generate a dry relay contact output that can be used as an input to the PLC/ SCADA system.

4. 5. Power supplies shall be Phoenix Contact 24 VDC Quint series, or equal.

L. Wire Labeling

1. Labels for coding 600-volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.

2.04 ELECTRICAL COMPONENTS

A. General Purpose Relays

1. General purpose relays in the control panel(s) shall be compact plug-in type with contacts rated 10-Amps at 120 VAC; or 24 VDC.

a. Quantity and form of contacts shall be as required by the application.

b. The relay shall have a minimum of two (2)-form C contacts (double pole-double throw), except when used as interpose relay for the PLC's DO modules.

c. Interpose relay for the PLC's DO modules shall have a minimum of one (1)-form C (single pole single throw) contacts. Each relay shall be provided with a neon light to indicate energized state.

2. The relay socket and mounting shall be a standard DIN rail mount with pullover wire spring.

3. Relays shall be IDEC compact relays 2213, or approved equal.

B. Interpose Relays

1. Additional relays shall be provided when the number or type of contacts required exceed the contact capacity and/or rating of the specified relays and timers.
2. Additional relays shall be provided when higher contact rating is required in order to interface with starter circuits or other equipment.
3. The interpose relays shall be as the general-purpose relays specified above.

C. Time Delay Relays

1. Time delay relays shall be plug-in electronic type with on-delay or off-delay actuation as required. Output contacts shall be double-pole double-throw (DPDT) rated 10-Amps at 120 VAC minimum. Each unit shall include an adjustable time delay with a time range scale. Operating temperature range of the units shall be -20 to +120 degrees-F minimum and each device shall be rated for 10,000,000 mechanical operations and 500,000 electrical operations.
2. Provide Idec RTE multi-function series, Schneider Electric, or approved equal.

D. Indicating Pilot Lights

1. Indicating lights shall be ultra-bright multiple LED cluster lamps, push-to-test full voltage and shall be heavy-duty, oil-tight construction. Operators shall be nickel or chrome plated. Each light shall have a screwed-on prismatic lens approximately 1-inch in diameter. Miniature style devices are not acceptable.
2. Lens colors shall be GREEN for "run," "open," or "on"; RED for "stopped," "closed," or "off"; and AMBER for alarm.
3. Indicating lights shall be Square D Company, Class 9001 Type K, General Electric Company Type CR104P, or approved equal. Each light shall have a factory-engraved legend plate, as shown on the Contract Documents.

E. Selector and Pushbutton Switches

1. Selector and pushbutton switches shall be rated 10-amperes at 600 volts; shall be heavy-duty, oil-tight construction; and shall have the number of positions and poles required. Miniature style devices are not acceptable. Operators shall be nickel or chrome plated. Switches shall be Square D Company, Class 9001 Type K, General Electric Company Type CR104P, or approved equal. Each switch shall have a factory-engraved legend plate as shown on the Contract Documents.

F. Signal Isolators, Conditioners and Converters

1. Signal isolators conditioners and converters shall be provided as required to resolve any signal level incompatibilities, to ensure adjacent component impedance match where feedback paths may be generated, or to maintain loop integrity during the removal of a loop component.
2. Signal isolators, integrators and converters shall be 24 VDC or 120 VAC powered as applicable, and shall DIN rail mounted. Isolators shall be by Phoenix Contact, or approved equal.

G. 24VDC Power Supplies

1. Control panels shall be provided with redundant power supplies which shall be configured in a fault-tolerant manner to prevent interruption of service upon failure and interruption of service necessitated by the replacement of a power supply.
2. The CONTRACTOR shall size the power supplies to meet the control panel requirement and the instruments and loops they support. Power supplies shall have an excess rated capacity of 40 percent. The failure of a power supply shall be alarmed at the SCADA System.
3. The failure of a power supply shall generate a dry relay contact output that can be used as an input to the PLC/ SCADA system.

4. 5. Power supplies shall be Phoenix Contact (10A rated min.) 24 VDC Quint series, or equal.
5. 24VDC Power Supply Redundant Module
6. 24VDC Power supply for control panel shall be provided with redundancy module of the same supplier as the power supply.
7. Phoenix Contact – QUINT-ORING/24DC/2X10/1X20, Catalog No. 2320173, or equal.
8. Performance:
    a. Nominal input voltage: 24 V DC.
    b. Input voltage range: 18 V DC to 28 V DC (SELV).
    c. Number of inputs: Two (2) independent DC inputs.
    d. Number of outputs: Option 1: 2 × 10 A outputs or Option 2: 1 × 20 A combined output.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Preparation for Shipment and Shipping
    1. Control panels shall be crated for shipment using a heavy framework and skids as required and cushioned to protect the finish and the instruments during shipment. Provide sufficient cushioning material to protect interior hardware that could be damaged due to mechanical vibrations.
    2. Each panel unit shall be provided with removable lifting lugs to facilitate handling.

3.02 INSTALLATION

A. Control panels shall be installed in accordance with Section 17010 – Instrumentation and Controls for Process System and located as indicated in the Contract Drawings.

B. All conduit and cable entrance shall be from bottom entry only, unless otherwise specified by the Contract Drawings.

C. Wire Installation Requirements
    1. Wiring methods and materials for panels shall be in accordance with the NEC requirements and industry best practices.
    2. Wires shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals. Wiring run from components on a swing out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the hinge loop so that conductors are not strained at the terminals.
    3. Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and be secured to the inside face of the panel using adhesive mounts.

D. Wire Terminations
    1. Spare I/O shall be wired to a terminal strip and clearly marked.
    2. All field wiring shall terminate at a terminal block in the enclosure. Field wiring shall be terminated first at the field interface terminal block and then wired to the devices/instrument or PLC inside the panel.
        a. Except for antenna cable, Cat 5e cables and other specialty cables, such as thermocouples and data cables, field wiring shall not be wired directly to the panel mounted device.
    3. Terminals and fuses for each conductor and shield drain wire of a twisted shielded pair or triad cable shall be mounted consecutively next to each other.

4. Terminal blocks shall be grouped based on their function and voltage. Each group of terminal blocks shall be located in the panel to provide easy access, safety, practicality, and minimization of internal wiring.
5. Terminal blocks for 24 VDC signals shall be grouped separate from the power and other 120 VAC terminals.
6. Terminal blocks for 24 VDC signals shall be grouped separate from the 24VDC power as well. Likewise, terminal blocks for 120 VAC power and distribution shall be grouped separate from the 120 VAC terminals for control signals.
7. Each terminal and wire connection shall be tagged in accordance with the approved shop drawings or Facility standard tagging/numbering, if available.

3.03 MOUNTING HEIGHTS

A. Unless otherwise specified or a conflict exists, mount all control panels and field boxes 75” to top of cover.

3.04 IDENTIFICATION

A. Nameplates
   1. Provide nameplates for each device on or within the panels and enclosures. Nameplates shall be black laminated with white lettering, a minimum of 1” x 3” in size with up to three lines of ¼” lettering. Securely fasten nameplates in and situate them in a visible location and mechanically attached with self-tapping stainless-steel screws to the panel door. The nameplate to indicate panel name as indicated on drawings.

B. If more than one power source is present in a panel, a separate warning nameplate with red face and white core, mechanically attached with self-tapping screws to the panel door shall be provided. The nameplate to indicate the number of power sources and their origin.

C. All instruments within the panel shall be identified.

D. Provide a list of all circuit breakers and fuses laminated in plastic. The list shall be located in each associated enclosure.

E. All wires shall be identified.

3.05 FIELD QUALITY CONTROL

A. Calibration and testing shall be performed in accordance with Section 17010 – Instrumentation and Controls for Process Systems.

3.06 ADJUSTMENTS

A. Analog Loops: Whenever an existing analog loop is modified, the CONTRACTOR shall ensure that the integrity and isolation of the loop is maintained and the shield is grounded correctly. In modifying the analog loop, the CONTRACTOR shall also modify the 24 VDC to that loop so that the power supply source of that loop is part of the control panel and backed up by the UPS in it.

B. Field Connection Panels and Interface Terminal Blocks: In cases where field I/O wiring has to be extended to the control panel from enclosures that are removed or modified, the CONTRACTOR shall provide separate enclosures/field connection panel (FCP), as required, to which field I/O are wired, and from which the signals shall be wired to the control panel.

END OF SECTION

SECTION 17702
IN-LINE LIQUID FLOW MEASURING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, in-line liquid flow measuring systems, complete and operable, in accordance with the Contract Documents.

1.02 RELATED WORK

A. Division 16 Electrical Specifications

B. Section 17010 Instrumentation and Process Control Systems

1.03 SUBMITTALS

C. Furnish submittals in accordance with Section 17010 – Instrumentation and Process Control Systems.

PART 2 - PRODUCTS

2.01 MAGNETIC FLOW MEASURING SYSTEMS

A. Manufacturers: The Magnetic flow meter manufacturer and model flow meters shall be as follows or approved equal:

1. Siemens Sintrans FM MAG 5100 W with MAG 500 Trasmitter

B. Magnetic flowmeter system shall be suitable for the intended process and shall be based on the conductivity properties and solid content of the process fluid, in accordance with the manufacturer's recommendations.

1. Magnetic flowmeter system shall be capable of measuring fluid velocities in the range of 0.04 and 39 ft. /sec. in both forward and reverse flow in all sensor sizes.
2. Accuracy: The flow metering system shall be installed in accordance with the manufacturer's recommendations to provide at least 0.5 percent of flow rate from 10 to 100 percent full scale for velocities over 3 feet per second.
3. Repeatability: 0.1 percent of reading.
4. Power consumption shall be as indicated in the data sheet.
5. Power input requirements shall be as indicated in the data sheet.

C. The magnetic flow metering system shall include a metering tube, transmitter, and signal cable and flowmeter grounding rings.

1. Metering Sensor/Tube:

a. The metering sensor shall employ a pulsed DC technique to drive flux-producing coils. Sensors using high pulsed DC signals shall be used in accordance with the manufacturer's recommendations for the required service application and as indicated in the data sheet.

b. The metering tube sizes shall be available from at least 1-inch to 48-inch line size. It shall be sized in accordance with the installation application and the intended service and as recommended by the manufacturer, and as indicated in the data sheet. If fractional size or larger size meters are required, the manufacturer shall be consulted for availability.

c. Metering Sensor/Tube

- Flanged Connections: The flanges' size, style, type and construction material shall be in accordance with the required installation and the intended service application and as recommended by the manufacturer, and as indicated in the data sheet. Pressure ratings shall be as

indicated in the data sheet and in accordance with the requirements of process, as recommended by the manufacturer for the intended service.

- A minimum of two (2) electrodes shall be provided. The electrodes' material shall be suitable for the required service as recommended by the manufacturer, and as indicated in the data sheet. A reference electrode shall be provided as recommended by the manufacturer for the required installation application.
- Lining material shall be in accordance with the manufacturer's recommendation for the intended service, and as indicated in the data sheet.
- Meter housing shall be rated for NEMA 6P (IP68) (limited depth) and shall be offered with certified ratings for different hazardous locations as specified in the data sheet. It shall be able to operate between -20 to 140 Degrees F (-29 to 60 degrees C).
- Meter tube shall have epoxy protective coating.
- Grounding rings shall be provided and designed to protect and shield the liner's edge interface from abrasion at the meter end. Grounding rings shall conform to the manufacturer's bore and material recommendation for the intended service Grounding shall conform to the manufacturer's recommendations.

2. Transmitter/Converter

a. The transmitter/converter shall be capable of being mounted integral to the metering tube or remotely as indicated in the data sheet. Mounting hardware shall be provided. Refer to CONTRACT drawings for Transmitter/Converter mounting requirements.

b. The transmitter/converter shall be rated for NEMA 4X (IP67). Certified ratings for different hazardous locations shall be offered as an option as specified in the data sheet. It shall be able to operate in ambient temperatures of -20 to 140 degrees F (-29 to 60 degrees C).

c. The transmitter shall convert the DC pulse signal from the metering tube to a linear 4 to 20 mA DC signal into a minimum of 700 ohms. The 4-20 mADC signal shall comply with HART protocol. Output signal shall be continuously adjustable over the full scale. Other digital outputs options shall be available.

d. The transmitter shall have an LCD displays for flow rate, percent of span, totalization, operator configuration interface, and diagnostic information.

e. The transmitter shall have an adjustable integral low flow cutoff and zero return.

f. The transmitter shall perform self-diagnostics and automatic data checking and activate a switch closure output when a transmitter fault is detected.

3. Cables

a. Remote transmitter configuration shall be provided with the required lengths and types of electrodes and coil drive cables as recommended by the manufacturer for the required installation application. Maximum distance of transmitter from the metering tube shall be as recommended by the manufacturer.

D. Calibration: Each flow metering system shall be hydraulically calibrated at a facility that is traceable to the National Institute of Standards and Technologies. The calibration procedure shall conform to the requirements of ANSI/NCSL Z 540-1 Calibration. A real-time computer generated printout of the actual calibration data shall be submitted to the ENGINEER at least 30 Days prior to shipment to the site.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. In-line liquid flow measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 17010 – Instrumentation and Process Control Systems.

B. Manufacturer's service, supervision, and training shall also be in accordance with Section 17010 – Instrumentation and Process Control Systems.

END OF SECTION

SECTION 17710
PLC-BASED CONTROL SYSTEM HARDWARE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR through the use of the System Supplier shall provide programmable logic controllers (PLC)-based control system (PBCS) hardware for the I&CS, complete and operable, in accordance with the Contract Documents.

1. PLC-based control system software shall be provided by others.

B. The System Supplier shall be responsible for selecting, sizing, and providing the correct and necessary type and quantity of hardware for the entire PBCS and for each PLC. The necessary hardware shall include but not limited to servers, workstations, network hardware, PLC input/output (I/O) modules, interconnecting cables, accessories, communication ports, adapters and cards, and all appurtenances for proper operation of the PBCS and to meet the functional requirements described in these specifications, and as shown on the system architecture diagram or network diagram. The System Supplier shall be responsible for the interface to existing systems or those furnished by others.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Section 17010 - Instrumentation and Controls for Process Systems

B. Applicable Sections in Division 17 – Instrumentation and Control for Process Systems

C. Division 16 – Electrical

D. The PBCS equipment, materials, and other work shall conform to the specifications; codes and standards requirements specified Section 17010 - Process Control and Instrumentation System.

1.03 SUBMITTALS

A. The PLC submittal shall be provided in accordance with the requirements specified in Section 17010 – Process Control and Instrumentation System.

1.04 SPARE PARTS

A. Spare Parts:

1. It is intended that sufficient spare parts and supplies necessary to support the operation and maintain the system shall be furnished with the system. PLC system spare parts shall be furnished in accordance with Section 17010 - Process Control and Instrumentation System.

2. As a minimum, the spare parts listed below are required to be furnished under this contract

   a. One (1) PLC I/O card of each type.

   b. One (1) PLC CPU

   c. One (1) PLC memory card

   d. One (1) PLC communication module (if a separate module is required)

   e. One (1) PLC power supply

1.05 WARRANTY

A. The CONTRACTOR shall guarantee the performance of all the new PLCs' hardware as specified elsewhere in the Contract Documents.

B. All parts, material labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period shall be borne by the CONTRACTOR under the guarantee. Equipment and materials that do not achieve their intended purpose shall be replaced by the CONTRACTOR to attain compliance, at no additional cost to the OWNER.

C. Guarantee and special corrections of defects and upgrade requirements and warrantee shall be in accordance with Section 17010 - Process Control and Instrumentation System.

PART 2 - PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Manufacturer:

1. Allen-Bradley 5380 CompactLogix Controller, Catalog Number 5069-L330ER

B. Description:

1. The CONTRACTOR shall furnish all necessary hardware, interconnecting cables, all accessories, and all appurtenances as indicated herein or as required for proper operation of the PLC.
2. All PLC materials and equipment furnished for the PLC shall be standard off-the shelf commercially available products and shall be the product of a single manufacturer.
3. All components that are common to the PLCs shall be of the same manufacturer and family of PLCs. All the PLCs shall have the same components manufacturer (e.g. processor, memory, chassis style, I/O cards, etc.). Special minor interface hardware not provided by the PLC manufacturer can be a product by the manufacture's approved third party.

C. Performance / Design Criteria:

1. The PLCs shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:
   a. Ambient temperature range: 0°C through 60°C
   b. Thermal shock: 1.0° (1.8°F) per minute maximum
   c. Relative humidity: 95 percent maximum non-condensing
2. Construction: The PLC central processing unit (CPU) shall be modular unit which shall contain the operating logic. The input/output (I/O) modules shall also be modular and interface directly with the CPU through a back common panel or by a special cable if I/O expansion is required. The PLC shall provide a means for mounting the chassis in a standard cabinet or 19-inch rack. The PLC shall be capable of operating in a hostile industrial environment (i.e., heat, electrical transients, RFI, vibration, etc.) without fans, air conditioning, or electrical filtering and be designed to provide high reliability specifically in this process application.
3. The PLC shall be of modular, field expandable design allowing the system to be tailored to this process control application. The capability shall exist to allow for expansion of the system by the addition of hardware and/or user software. The PLC shall be provided with I/O (input/output) modules and with sufficient memory, power and appropriate cables to be able to interface with new and existing field devices, necessary to function as a complete and operable PLC system.
4. Logic functions must perform in a given application shall be programmed into the PLC memory. All equipment shall be capable of tolerating and capable of riding through a power interruption of 8 milliseconds or less without interruption of normal operation and communication.
5. It is the intent of these specifications to provide PLCs which can be easily expanded and configured. Therefore, all changes in system architecture, expansion of I/Os, modification to and implementation of control strategies shall be easily done on-site
6. PLC Growth Provisions
   a. All equipment and resources, including PLC, I/O cards and implementation services, shall be provided such that project memory and I/O growth can be implemented into the PBCS without any additional cost to the OWNER.

b. The I/O points included in the 20 percent project I/O growth requirement shall be termed “implemented spare I/O” (wired to field terminals). The 20 percent implemented spare I/O is 20 percent of each type of the total project I/O listed and may be implemented in any one or more I/O cards and racks at the direction of the OWNER at any time throughout the duration of the project until the beginning of factory testing. Subsequent to factory testing the unused implemented I/O, if any, shall be delivered to the OWNER as spare I/O.

c. Implementable spare I/Os shall mean that each of these I/O shall also be wired to the field interface terminals.

d. Future and Spare Signal (i.e. the source of inputs or final control elements for DO and AO are not yet known or available in the field). The percent of additional terminals for future signals (not implemented) shall be in accordance with the requirements specified in Section 40 95 13 - Control Panels.

e. Spare Empty I/O Module Slots: Each new PLC location shall be provided with three (3) empty I/O module slots.

7. Central Processor Unit

a. The central processor shall contain all the relays, timers, counters, registers, sequencers, and arithmetic capability necessary to perform the specified control functions. It shall be sized to be capable of interfacing with sufficient discrete inputs and outputs, analog inputs and outputs to meet the specified requirements plus the required project percent growth as specified above, or as required by the I/O list, whichever is greater. The CPU shall be a self-contained unit, and shall provide control program execution and support remote or local programming. The PLCs shall be provided to support and implement closed loop floating and PID control which is directly integrated into the PLC program.

b. The CPU shall be furnished with a watchdog timer. The processor shall have a key type memory protect switch to prevent unauthorized program changes.

c. The CPU shall perform internal diagnostic checking within the system and give visual indication to the user when no fault is detected and when a fault is detected. If power to the CPU fails or gets disconnected the processor shall cease operation, forcing all outputs off.

8. Memory

a. The PLC shall be supplied with sufficient memory to implement the specified control function plus a reserve capacity for project growth requirements as specified above. This reserve capacity shall be totally free from any system use.

b. A minimum of 3 MB of user memory shall be furnished with each PLC. . Additional memory shall be furnished where necessary to accommodate the I/Os and functional requirements.

c. The memory shall be programmed in a multi-node configuration with multiple series or parallel contacts, counters, timers, and arithmetic functions.

d. It shall be possible to upgrade to a processor with a larger memory size simply by saving a program, replacing the processor, and downloading the program to the new system without having to make any program changes.

e. User memory in the processor not used for program storage shall be separated from main memory for the purpose of data storage.

f. Battery: The PLC memory shall have a battery backup or other means of backup. The programming memory shall be with sufficient backup to retain the program during power interruptions of up to 1 year. The capability shall exist to remove all batteries from the system without removing system power. An indicator shall show the status of

the batteries (if used). A low battery condition must be detectable in ladder logic, but shall not automatically generate a major fault.

D. Materials / Components

1. Input / Output Modules

a. General

- All I/O housings and I/O modules shall suitable for hostile industrial environments as described above. All I/O modules shall be isolated and conform to IEEE Surge Withstand Standards and NEMA Noise Immunity Standards. Modules shall be removable without having to disconnect wiring from the module's terminals by means of a swing-arm or plug-in wiring connector. Sufficient input and output modules shall be provided with at each PLC location to implement the specified control functions plus the required project percent growth and spare of I/O as specified above or as required by the I/O list, whichever is greater. The I/O modules shall be from the same manufacturer as the processor.

b. Power input (see also paragraph “PLC Power Supply”):

- The modules shall operate on an external 24 VDC power supply.

c. During normal operation, a malfunction in any remote input/output channel shall affect the operation of only that channel and not the operation of the CPU or any other channel. Any remote input/output channel shall be field selectable to shut down the CPU upon failure of that channel. Upon remote channel shutdown the CPU shall see all inputs on the malfunctioning channel as they were when the shutdown occurred and all outputs shall de-energize on that channel.

d. All internal logic and circuits shall be isolated from and external power circuits. This isolation shall meet the minimum IEEE specification of 1500 VRMS.

e. Combination Modules – A Module that provides a combination of discrete inputs and outputs or analog inputs and outputs can be used as long as the I/O quantities meet the system requirements. The specification of each group if I/O must also meet the specification as if it is an individual type module.

2. Discrete Input Modules

a. Discrete (digital) input (DI) module shall accept DI signals, which is defined as a dry relay contact closure inputs signal from devices external to the PLC.

- 16 channel digital AC input Module 5069-IA16.
- Voltage Range: 79 … 132 V @ 47 … 63 Hz.

b. PLC module Input modules shall be shielded from short time constant noise and 60-Hz pickup. Individual inputs shall be optically isolated for low energy common mode transients to 1500 volts peak from user's wiring or other I/O modules and shall have IEEE surge withstand protection. All inputs shall be isolated from each other.

c. The module shall be capable of accepting normally open and normally close input contacts, and to change the input in the module through programming if the contact in the field changes from normally open contact to normally close.

3. Discrete Output Modules

a. Discrete (digital) output (DO) module shall produce contact closure output (DO) signals to interface or operate equipment and devices external to the PLC module.

- 16 channel discrete output Module 5069-OA16.
- Voltage Range: 5 … 265 VAC; 5 … 125 VDC.

b. The output modules shall be optically isolated from inductively generated, normal mode and low energy, common mode transients to 1500 volts peak and shall have IEEE surge withstand protection. Each output point shall be individually isolated and fused.

c. If required, each of the module's output shall interface with an external and separately mounted relay (interpose relay) that shall provide the dry discrete contact output. Relays shall be accordance with in Section 409513 - Control Panels.

4. Analog Input Modules

a. This module shall accept 4 to 20 mAdc analog input signals. The module shall perform an analog to digital conversion where an analog to digital conversion is performed with 16-bit precision and the digital result is entered into the processor.

- 8 channel analog input module 5069-IF8.
- Signal Range: 4 … 20 mA.

b. External 24 VDC power supply shall power the 4-20 mAdc 2-wire transmitters/ loops. Input modules shall be source or sink to accommodate 2-wire or 4-wire transmitters respectively. Analog input modules shall have 8 differential inputs each and shall be isolated from each other.

5. Analog Output Modules

a. This module shall provide for 4-20 mAdc analog signals output. Each analog output module shall have 4, 6, or 8 isolated output points which shall be rated for loads of up to 1200 ohms.

- 8 channel analog output Module 5069-OF8.
- Signal Range: 4 … 20 mA.

b. The module shall perform a digital to analog conversion with each scan of the processor and the analog result produced as an output. New outputs shall be produced on every scan. Analog outputs shall be isolated in the same manner as the analog input modules.

6. PLC and I/O Housings: The PLC, power supply, and I/O modules shall be mounted in suitable standard housings. Individual housing slots shall be mechanically configurable to prevent insertion of incorrect modules. Each new PLC location shall have empty I/O module slots to accommodate the required project growth requirements as specified above. The PLC shall also be provided with all the necessary mounting hardware, connectors, and cables. Filler plates shall be provided for unused slots in the PLC rack.

7. PLC Power Supply

a. The PLC, I/O Modules and the analog and digital loops shall be powered by a single main external source of redundant set of 24 VDC power supply system, the redundant power supplies shall be configured in a fault-tolerant manner in order to prevent interruption of service upon failure and interruption of utility power or service necessitated by the replacement of a power supply.

b. The 24 VDC power supplies shall have 120 V, 60 Hz input, a 24 VDC linear output, with +/- 0.05% line and load regulation. Power supplies shall be designed for parallel wiring of the 24 VDC output. Power supplies shall be power factor correcting and shall have short circuit and overload protection. Each power supply shall be sized at twice the initial connected load including slave and interposing relays.

c. The power supply shall include diagnostic indicators to provide the operator with the status of the DC power applied and the redundancy. Each 24 VDC power supply shall also include status and fault LED indicators and a fault/redundancy status monitoring dry contact output. The fault status output contact of each power supply shall be wired to its own PLC digital input (DI).

d. In all cases, the analog and digital loops shall be powered by an external redundant 24 VDC power supplies as specified above.

e. The power supply shall monitor the incoming AC line voltage for proper levels and shall automatically shut down the PLC system whenever its output current is detected to be at improper levels. Power supplies shall have fuse protection. In addition, a means of disabling power to the CPU shall be possible from a power disconnect switch or fuse.

2.02 HUMAN INTERFACE MACHINE (HMI)

A. Manufacturers:

1. The HMI shall be Automation Direct C-MORE 15" TFT Color Touch Panel – Full Mode Series CM5-T15W.

2. Description: The CONTRACTOR shall furnish a Human Interface Machine unit (HMI) and software with the following features:

a. Materials / Components:

- 15" inch (minimum) panel mounted monitor with touch screen controls. Resolution shall be HD (1024x768 pixels) with 280 NITS display brightness.
- Ports: Ethernet 10/100 Base-T, 2 USB ports, RS-232/422/485
- Memory – built-in SD memory card slots provided with enough memory to support SCADA Application.
- Power – 24 VDC

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. The CONTRACTOR shall provide the OWNER with training on the subjects of use, maintenance, operation, troubleshooting and repair of all the components of the PLCs and the rest of the PBCS hardware. The training shall be specifically tailored to this project and reflect the hardware and the installation. All training shall be conducted on site unless another location is approved by the ENGINEER and OWNER. Hardware training subjects and the allocated hours for each class shall be in accordance with Section 17010 - Instrumentation and Controls for Process Systems.

END OF SECTION

SECTION 17725
INDUTRIAL NETWORK HARDWARE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR through the use of the System Supplier shall provide the network devices, mounting hardware, wireless access points, switches, and accessory hardware for the I&CS, complete and operable, in accordance with the Contract Documents.

B. The System Supplier shall be responsible for selecting, sizing, and providing the correct and necessary type and quantity of hardware for the entire PBCS. The necessary hardware and software shall include but not limited to workstations, network hardware, interconnecting cables, accessories, communication ports, adapters and cards, and all appurtenances for proper operation of the PBCS and to meet the functional requirements described in these specifications, and as shown on the system architecture diagram or network diagram. The System Supplier shall be responsible for the interface to existing systems or those furnished by others. The System Supplier shall also provide the latest version of software to enable the programming and the integration of the PBCS.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Section 17010 - Instrumentation and Controls for Process Systems

B. Section 17720 – PLC-Based Control System Software

C. Applicable Sections in Division 17 – Instrumentation and Control for Process Systems

D. Division 16 – Electrical

E. The PBCS equipment, materials, and other work shall conform to the specifications; codes and standards requirements specified Section 17010 - Process Control and Instrumentation System.

1.03 SUBMITTALS

A. The PLC submittal shall be provided in accordance with the requirements specified in Section 17010 – Process Control and Instrumentation System.

1.04 CLOSEOUT SUBMITTALS

A. Software: The CONTRACTOR shall provide and register the OWNER with all user software and hardware licenses. Additional contract, agreements and licenses requirements shall be in accordance with Section 17010 - Process Control and Instrumentation System.

1.05 SPARE PARTS

A. Spare Parts:

1. It is intended that sufficient spare parts and supplies necessary to support the operation and maintain the system shall be furnished with the system. PLC system spare parts shall be furnished in accordance with Section 17010 - Process Control and Instrumentation System.

2. As a minimum, the spare parts listed below are required to be furnished under this contract

   a. One (1) Managed (Fiber Optic) Ethernet switch

   b. Two (2) SFP Modules

1.06 WARRANTY

A. The CONTRACTOR shall guarantee the performance of all the new PLCs and the programming software for them as specified elsewhere in the Contract Documents.

B. All parts, material labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period shall be borne by the CONTRACTOR under the guarantee. Equipment, software, and materials that do not achieve their intended purpose shall be replaced by the CONTRACTOR to attain compliance, at no additional cost to the OWNER.

C. The guarantee and special corrections of defects and software upgrade requirements and warrantee shall be in accordance with Section 17010 - Process Control and Instrumentation System.

PART 2 - PRODUCTS

2.01 LOCAL AREA NETWORK HARDWARE

A. Manufacturers:

1. The ethernet managed switches shall be MOXA EDS 518E SS-SC-4GTXSFP or approved equal**.**

2. Description:

a. Network devices shall be furnished and installed by the CONTRACTOR as detailed in this section and as shown and/or specified on the Network Diagrams. Firmware modules, where applicable shall be installed. The network devices should be of the latest revision. If the specified model has been or is currently scheduled to be discontinued by the manufacturer, the CONTRACTOR shall furnish (with the approval of the ENGINEER) the manufacturer recommended replacement model of equal or better functionality, performance and reliability.

b. The CONTRACTOR shall also be responsible for configuring new and if applicable, existing network hardware, verifying the firmware, adding communication modules (and other network hardware components as specified) and configuring the network modules to ensure successful working integration with the control system communication network per the contract requirements.

B. Design Criteria:

1. The new LAN hardware shall comply with the IEEE 802.3 standards for Ethernet and operate at a minimum bandwidth of 100Mbps.

2. The network topology shall permit either switched 100BASE-TX or 1000BASE-TX connections through an auto-negotiating switched hub.

3. The switch shall meet the following requirements

a. Power Input- 24 VDC

b. UL listed

c. Din rail mount

d. 30-percent of the ports shall be kept unused (spare)

2.02 NETWORK HARDWARE ACCESSORIES – SFP MODULES

A. Manufacturers:

1. The SFP module shall be of the same manufacturer of the ethernet managed switches, MOXA SFP-1G Series 10km distance single mode transceivers or approved equal.

B. Description:

1. The SFP modules shall be furnished and installed by the CONTRACTOR as specified herein and as indicated on the CONTRACT DRAWINGS. The modules shall be fully compatible with the MOXA EDS 518E SS-SC-4GTXSFP industrial Ethernet switch and shall be of the latest hardware revisions available at the time of installation.

a. Installation shall include proper insertion into the SFP ports, connection of all required fiber optic cabling, and verification that each module is correctly seated, recognized by the switch, and functioning properly.

b. Configuration and verification of link status, diagnostics, and communication performance shall be performed by the City Programmer. The CONTRACTOR shall

coordinate with the City Programmer as necessary to facilitate successful network integration and testing.

2. If the specified model has been discontinued or is scheduled for discontinuation, the CONTRACTOR shall provide, subject to approval by the ENGINEER, the manufacturer's recommended replacement with equal performance, temperature rating, and compatibility.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. The CONTRACTOR shall provide the OWNER with training on the subjects of use, maintenance, operation, troubleshooting and repair of all the components of the network rack and the rest of the PBCS hardware. The training shall be specifically tailored to this project and reflect the hardware and the installation. All training shall be conducted on site unless another location is approved by the ENGINEER and OWNER. Hardware training subjects and the allocated hours for each class shall be in accordance with Section 17010 - Instrumentation and Controls for Process Systems.

END OF SECTION

SECTION 17800
TESTING CALIBRATION AND INSTALLATION VERIFICATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR through the System Supplier shall provide all necessary testing, instrument calibration, and installation verification, for each system and piece of equipment complete with written reports prior to system completion. After system completion (or part thereof), the CONTRACTOR shall commence commissioning and start-up activities as specified in Section 17830 – Instrumentation and Control Test Forms.

B. Conform to the general requirements of Section 16950 – Electrical Tests regarding testing of the instrumentation and control equipment and coordinate instrumentation and control work to facilitate testing of other equipment. Use test forms and requirements as detailed in Section 17830 – Instrumentation and Control Test Forms.

C. Refer to Section 17010 for general instrumentation and control requirements related to testing, calibration, and installation verification.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Section 17010 - Instrumentation and Controls for Process Systems

B. Applicable Sections in Division 17 – Instrumentation and Control for Process Systems for related testing, commissioning and start-up requirements of the I&CS.

C. Division 16 – Electrical.

1.03 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals and 17010 - Instrumentation and Control for Process Systems.

B. The CONTRACTOR shall furnish all Instrumentation and Control Test Forms as required by Section 17010 – 1.07 Closeout Submittals.

1.04 COORDINATION

A. Coordinate Testing and commissioning activities with Prime Contractor, supplier of process equipment representatives and other divisions.

B. Refer to Section 01670 – Equipment And System Testing And Startup for additional information and requirements.

PART 2 - PRODUCTS - NONE

PART 3 - EXECUTION – NONE

3.01 TESTING

A. Prior to the completion of the Work, perform comprehensive testing of the installation. Include the following activities:

1. Wire insulation tests.
2. Wire continuity tests including associated terminations.
3. Grounding system continuity and isolation tests.
4. Any other testing necessary to verify the operation of equipment and installation work.

B. Provide the services of a manufacturer’s representative for equipment to assist with any of the equipment tests to be performed. Any components, incorrect wiring, or systems found to be defective or deficient during the tests shall be repaired or replaced.

C. Provide a detailed test schedules to ENGINEER for review and approval as part of the Quality Control plan.

D. The participation in testing activities and use of the equipment during testing periods by OWNER is to be allowed provided it does not adversely affect specified testing requirements. Such participation shall not relieve the CONTRACTOR of any of the obligations stipulated herein.

E. Prior to the commencement of any testing, the CONTRACTOR shall ensure that all spare parts, expendables, and test equipment pertinent to the system being tested are on site. Test equipment shall include all necessary multi-meters, process instrument calibrators for 4-20 mA loops, 24 VDC devices and signal generators or simulators. Test equipment shall be provided by the Contractor and shall remain the property of the CONTRACTOR at the end of all testing.

3.02 CALIBRATION

A. Calibrate and adjust all instrumentation to verify correct operation, range adjustment, compensation, scaling, etc. Provide instrument calibration services for all individual components such as signal transmitters, analyzers, transducers, power supplies, and like equipment where appropriate.

B. Provide certified calibration reports for each instrument. In the reports, include, but do not limit to, such information as:

1. Device tag number.
2. Equipment description.
3. Service application.
4. Process variable measurement range.
5. Description of calibration equipment used.
6. “As found” calibration data.
7. “As left” calibration data.
8. Date, name, and signature of technician.

C. Include calibration reports in the operating and maintenance manuals described in Section 17010 and section 17830.

3.03 INSTALLATION VERIFICATION

A. When the system installation has been completed (or part thereof), perform detailed verification checks for all systems supplied and installed as part of the scope. In the checks and reviews, include the following:

1. Certify that the equipment has been installed as per the Contract drawings and recommended installation procedures, reporting any discrepancies to the ENGINEER.
2. Certify that the equipment power and grounding requirements have been satisfied, reporting any discrepancies to the ENGINEER. For the grounding system, include an itemized check of each instrument circuit to verify the correct isolation of all shields and instrument grounds.
3. Certify that all terminations to the equipment are properly installed. Report any discrepancies to the ENGINEER.
4. Certify that all wiring continuity (whether new or existing) has been verified.
5. Certify that all process taps and instrument connections have been performed according to the requirements detailed herein and shown on the drawings.
6. Certify that the installation (or part thereof as completed) is ready for commissioning and start-up.
7. Witnessed Functional Acceptance Test shall be done on the complete control system. During this test, the CONTRACTOR has to execute component by component and loop by loop

tests. The correct results have to be verified in the field and on the associated control components. The test shall be performed using approved procedures and shall be signed off upon satisfactory completion.

B. Undertake any corrective action found to be necessary during the course of the verification checkout and review.

C. Report any discoveries of defects or deficiencies in writing to the ENGINEER for any equipment supplied by the OWNER.

D. Allow for the participation of the Owner's personnel in the verification checks. Such participation shall not relieve the CONTRACTOR of any of the obligations.

E. Prepare the various reports and certificates described herein. Forward three (3) copies of each report or certificate to the ENGINEER. Clearly identify any discrepancies which require action on the part of the ENGINEER.

3.04 FIELD INSTRUMENTATION CHECKLIST

A. The following is a minimum checklist for all field-mounted devices:

1. Instrument cables and the individual conductors are tagged and identified.
2. Instrument cables are terminated on approved termination blocks.
3. Conductors are terminated in an approved manner on termination blocks and at connection points on the instrument.
4. Where required plug and receptacles have been used to connect field devices.
5. Termination boxes and junction boxes are identified and tagged.
6. Instrument cables are supported and strapped.
7. Field Instruments (flow meter, level transmitter, etc.) are tagged and identified.
8. Instruments are bonded to ground, and signal shield is not bonded to ground except at the host controller. (Signal shield is continuous and not bonded to any other signal shields in the field or field JB).
9. Instruments are adequately supported.
10. Instruments are located free of mechanical damage.
11. Instruments are new.
12. Instruments are free of dents, scratches, cracks, breaks, defects and damage.
13. Instruments are rated for the environment in which they are placed (indoor, corrosive, classified, outdoor, etc.).
14. Flexible connections or fittings are used to connect to the instruments.
15. Fittings for connections are water tight and secure.
16. Instrument control wiring is separated from power wiring.
17. Instrument control cable is shielded, twisted or configured in an approved manner to minimize electromagnetic and electrostatic interference.
18. Instruments are tested, calibrated and adjusted to operate within prescribed parameters.
19. 'Loop check sheets' and 'instrument calibration sheets' have been completed for each device.
20. Exact Instrument location has been signed off with OWNER and the ENGINEER.
21. All equipment will bear the UL label.
22. Wiring at different voltage levels within the same panel or termination box are segregated by an effective barrier.

23. A minimum clearance of 2” is provided between the wire-way and any point of wire termination.

END OF SECTION

SECTION 17830
INSTRUMENTATION AND CONTROL TEST FORMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The CONTRACTOR, in cooperation with ENGINEER and System Supplier, shall perform commissioning and start-up testing to verify the operation of all the systems as described herein after the installation is completed.

B. The Sytem Supplier, under the direction of the General Contractor, will coordinate and schedule all activities associated with testing and commissioning in accordance with Section 17010 - Instrumentation and Controls for Process Systems.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Section 17010 - Instrumentation and Controls for Process Systems

B. Applicable Sections in Division 17 – Instrumentation and Control for Process Systems for related testing, commissioning and start-up requirements of the I&CS.

C. Division 16 – Electrical.

1.03 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01300 – Submittals and 17010 - Instrumentation and Control for Process Systems.

B. The CONTRACTOR shall furnish all Instrumentation and Control Test Forms as required by Section 17010 – 1.07 Closeout Submittals.

1.04 QUALITY ASSURANCE

A. The CONTRACTOR shall use only approved forms by the ENGINEER to perform loop testing.

B. The CONTRACTOR and System Supplier shall be responsible to provide a coordinated commissioning and start-up program. The overall program will be presented to the owner and ENGINEER for approval prior to testing and commissioning activities as part of the shop drawings approval process.

PART 2 - PRODUCTS - NONE

PART 3 - EXECUTION - NONE

TEST FORM NUMBER AND DESCRIPTION

17830-A	LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM
17830-B	FIELD SWITCH CALIBRATION TEST DATA FORM
17830-C	TRANSMITTER CALIBRATION TEST DATA FORM
17830-D	MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM
17830-E	INDIVIDUAL LOOP TEST DATA FORM
17830-F	VISUAL AND MECHANICAL INSPECTION FORM
17830-G	I/O POINT CHECKOUT TEST FORM
17830-H	FACTORY TEST FORM

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17830-A: LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM

LOOP TAG: _____

List each conductor of all cables associated with a loop in table below. Ensure end devices are disconnected prior to making measurements. Perform continuity measurements with a 4,000 count DVM. Perform insulation resistance measurements with an insulation tester with energization voltage of 250V DC or less. Do not use a high voltage or hand-crank megohmmeter for this test.

Submit up to 5% of conductor recorded retest results when requested by the Engineer.

CABLE NO.	CONDUCTOR NO. (OR COLOUR)	CONTINUITY RESISTANCE[A]	SHIELD CONTINUITY INSULATION RESISTANCE[B]

A Continuity Test: Connect ohm meter leads between conductors 1 and 2 and jumper opposite ends together. Record resistance in table. Repeat procedure between conductors 1 and 3, and 4, etc. and finally between conductor 1 and cable shield. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor. Take corrective action before continuing with the loop test.

B Insulation Test: With all conductors open, measure the insulation resistance between conductor 1 and shield. Repeat procedure for each conductor and record reading.

CERTIFIED _____ DATE _____
Contractor's Representative

WITNESSED _____ DATE _____
Owner's Representative

17830-B: FIELD SWITCH CALIBRATION TEST DATA FORM

TAG NO. AND DESCRIPTION: _____

MAKE AND MODEL NO.: _____

_____

SERIAL NO.: _____

INPUT: _____

RANGE: _____

_____

SETPOINT(S): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired setpoint(s). Run through entire range of switch and calculate deadband.

Perform two tests per device or switch and record results.

SETPOINT	TRIP POINT (EU)		DEADBAND	
	INCREASE INPUT	DECREASE INPUT	CALCULATED	REQUIRED

CERTIFIED _____ DATE _____

Contractor's Representative

WITNESSED _____ DATE _____

Owner's Representative

17830-C: TRANSMITTER CALIBRATION TEST DATA FORM

TAG NO. AND DESCRIPTION: _____

MAKE AND MODEL NO.: _____

SERIAL NO.: _____

INPUT: _____

SUPPRESSION: _____

RANGE: _____

SCALE: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% OF RANGE	INPUT	OUTPUT		% DEVIATION
		EXPECTED	ACTUAL	
0				
25				
50				
75				
100				
75				
50				
25				
0				

NOTE: If transmitter includes integral switches include Form 16900-G for each switch.

CERTIFIED _____ DATE _____

Contractor's Representative

WITNESSED _____ DATE _____

Owner's Representative

17830-D: MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

TAG NO. AND DESCRIPTION: _____

MAKE AND MODEL NO.: _____

SERIAL NO.: _____

SERVICE: _____

INPUT: _____

DATA SHEET: _____

SUPPRESSION: _____

RANGE: _____

SCALE: _____

	TEST 1				TEST 2			
TEST METHOD								
	INPUT		**OUTPUT**		**INPUT**		**OUTPUT**	
PROCESS	**INC.**	**DEC.**	**INC.**	**DEC.**	**INC.**	**DEC.**	**INC.**	**DEC.**
TEST POINT 1								
TEST POINT 2								
TEST POINT 3								
TEST POINT 4								
TEST POINT 5								
COMMENTS								
GRAPHS								

CERTIFIED _____ DATE _____
Contractor's Representative

WITNESSED _____ DATE _____
Owner's Representative

17830-E: INDIVIDUAL LOOP TEST DATA FORM

LOOP NO.: _____

DESCRIPTION: _____

Give complete description of loop's function using tag numbers where appropriate

P & ID NO.: *Attach copy of P & ID*

1. Wiring tested (*attach test Form 17830 -A or equivalent*).

2. Instruments calibrated (*attach test Forms 17830-I through K*).

3. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Engineer's approval.

4 List step-by-step procedures for testing loop failure action. This testing to include loop operation upon loss of motive air supply, modulating control air signal, modulating control electrical signal and solenoid energizing power.

5. Sort all test forms associated with the P & ID in ascending order by loop number (*attach all associated instrument loop diagrams and interconnecting wiring diagrams*).

CERTIFIED _____ DATE _____

Contractor's Representative

WITNESSED _____ DATE _____

Corporation's Representative

17830-F: VISUAL AND MECHANICAL INSPECTION FORM

Equipment Name:	_____	**Location:**	_____
Manufacturer:	_____	Series#:	_____
Model #:	_____	U.L. #:	_____
Voltage:	_____	Phase:	_____
Amperage:	_____	Service:	_____
Bus Type:	_____	Bus Bracing:	_____
Vertical Bus:	_____	Horizontal Bus:	_____
Ground Bus:	_____	Neutral Bus:	_____
Enclosure:	_____	Environ. Rating:	_____

Inspection Checklist

Check: **A** – Acceptable, **R** - Needs Repair or Replacement, **NA** – Not Applicable

		Accept	Repair	NA
1.	Tighten All Bolts and Screws	❑	❑	❑
2.	Tighten All Wiring and Buss Connections	❑	❑	❑
3.	Verify All Breakers and Fuses Have Proper Rating	❑	❑	❑
4.	Check Bus Bracing and Clearance	❑	❑	❑
5.	Check Main Grounding Connection and Size	❑	❑	❑
6.	Inspect Ground Bus Bonding	❑	❑	❑
7.	Check Equipment Grounds	❑	❑	❑
8.	Check Conduit Grounds and Bushings	❑	❑	❑
9.	Inspect Neutral Bus and Connections	❑	❑	❑
10.	Check Heaters and Thermostats	❑	❑	❑
11.	Check Ventilation and Filters	❑	❑	❑
12.	Check for Broken or Damaged Devices	❑	❑	❑
13.	Check Door and Panel Alignment	❑	❑	❑
14.	Inspect Anchorage	❑	❑	❑
15.	Check for Proper Clearances and Working Space	❑	❑	❑
16.	Remove All Dirt and Dust Accumulation	❑	❑	❑
17.	Inspect All Paint Surfaces	❑	❑	❑
18.	Check for Proper Wire Color Codes	❑	❑	❑
19.	Inspect all Wiring for Wire Labels	❑	❑	❑
20.	Check for Proper Wire Terminations	❑	❑	❑
21.	Check for Proper Wire Sizes	❑	❑	❑
22.	Inspect All Devices for Nameplates	❑	❑	❑
23.	Check if Drawings Match Equipment	❑	❑	❑
24.	Check Accuracy of Operation & Maintenance	❑	❑	❑

Tested by:_____

Witnessed by:_____**Date:** _____/_____/_____

17830-G: I/O POINT CHECKOUT TEST FORM

I/O Type: _____ **Location:** _____

I/O Point Tagname	I/O Point Address	Test Input Value %			Display Value %			PLC Register Value	Test Result Fail or Pass Comments	Date of Corrective Action
		0	50	100	0	50	100			

Notes:

_____
_____
_____
_____
_____

Tested by:_____

Witnessed by:_ **Date:** _____/_____/_____

17830-H: FACTORY TEST FORM (MCC BUCKET / CONTROL PANEL / PEDESTAL CHECKOUT FORM)

Manufacturer: _____ **Location:** _____

_____ **Job No.:** _____

Telephone #: _____ **Fax #:** _____

MCC Bucket / Control Panel Pedestal: _____

	Test Result	
	Pass	**Fail**
OVERALL PANEL INSPECTION		
1. All front panel and back panel components counted securely.	❑	❑
2. All wiring terminated and labeled correctly.	❑	❑
3. All components, wiring, and labeling accurately reflected on the drawings.	❑	❑
POWER-UP INSPECTION		
1. Voltage levels on load side of circuit breakers.	❑	❑
2. Voltage levels at the DC terminals of the power supply.	❑	❑
3. Voltage levels at the DC power distribution terminals.	❑	❑
POWER DISTRIBUTION AND GENERAL COMPONENT TESTING		
1. Power distribution to the appropriate components.	❑	❑
2. Operation of the ancillary components such as receptacles, work lights, etc.	❑	❑
CONTROL COMPONENTS CHECKS		
1. Operators (push buttons, selector switches, pilot lights)	❑	❑
2. Inputs from External Sources	❑	❑
3. Outputs to External Sources	❑	❑
4. Relay Logic	❑	❑
5. PLC I/O and Program Verification	❑	❑
6. O/I Display Verification	❑	❑

Notes:

1. For relay logic checks, each rung of the elementary or loop diagram is to be highlighted in yellow as they are verified for correct control functions.
2. For PLC I/O and program verification, the control strategies shall be highlighted in yellow as each logic function is tested.

Tested by: _____

Witnessed by: _____ **Date:** _____/_____/_____

END OF SECTION