PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to provide an Air Emission Control System, as specified herein and as shown on the Drawings. The system shall include components and accessories for a thermal oxidizer, quench system, wet scrubber, stack, safety controls, process controls, combustion efficiency monitoring devices, and all components and accessories required for a complete factory assembled package.

1.02 RELATED WORK NOT INCLUDED

A. Field painting is included in Section 09902.
B. Air Strippers are included in Section 11350.
C. Duct work is included in Section 15890.
D. Fuel feed pumps are in Section 11245.

1.03 SYSTEM DESCRIPTION

A. The Air Emission Control System shall be designed to control the emissions from the Primary Air Stripper System and the controlled venting system of the process tanks upstream of the Air Stripper Systems as shown on the Drawings. These exhaust streams contain volatile organic compounds (VOCs) and, in particular, vinyl chloride (VC) which have to be destroyed before release to the atmosphere.

B. A thermal oxidation unit shall convert the VOCs to carbon dioxide and water vapor. After the oxidation unit, the exhaust gases shall pass through the quench system and into the wet scrubber system. In the quenching system, the hot gases will be cooled to about 180°F. In the wet scrubber, hydrochloric acid (HCl) formed during the thermal oxidation process shall be removed from the exhaust gas. The clean gas stream shall then be exhausted to the atmosphere via the stack.
C. The equipment shall be provided with sound adsorption to control the noise level emitted to the environment. The noise controls shall result in sound levels which meet both of the following conditions:

1. The maximum noise level from the system shall be less than 85 dBA at a distance of 5 feet from the unit.

2. The sound levels at the Contractor's Limit of Work, as shown on the Drawings, shall be less than those described by the Noise Criteria (NC) Curve of 35, from the ASHRAE Handbook, 1985 Fundamentals.

D. The unit shall operate without operator intervention during normal operation. In case of power failure, all controls shall be fail-safe.

E. The complete system shall be factory-assembled and skid-mounted to the greatest extent possible.

1.04 QUALIFICATIONS

A. All of the equipment furnished under this Section shall be supplied by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the system components to be furnished. The equipment shall be designed, constructed, and delivered in accordance with the best practices and methods.

B. The Air Emission Control System shall be manufactured by McGill Environmental Systems or approved equal.

1.05 SUBMITTALS

A. Submit copies of the following per the requirements of Section 01300 to the Government Contracting Officer for approval:

1. Literature and shop drawings describing the equipment and showing all important details, materials of construction, and dimensions. Sales literature will not be acceptable.
2. Structural design calculations for the foundation pad, equipment supports, and stack.

3. Motor data as described under Part 2 of this Section and in accordance with the requirements of Section 16150.

4. Complete wiring diagrams and schematics of all control panels and control devices furnished under this Section.

5. Complete wiring diagrams and schematics of each control system including connections to work of other Sections.

6. All the requirements of Section 01170.

7. Documentation of the manufacturer's ability to design and supply an effective Air Emission Control System, including descriptions of two existing systems designed and supplied by the manufacturer, with references who may be contacted to verify performance.

1.06 OPERATING INSTRUCTIONS

A. Operating and maintenance instructions shall be furnished in accordance with Section 01170 for all equipment included under this section. The instructions shall be prepared specifically for this installation.

B. Factory representatives who have complete knowledge of proper operation and maintenance of the equipment shall be provided for a total of five 8-hour days to inspect the equipment and to instruct representatives of the Government on proper operation and maintenance, startup, shutdown, lubrication, troubleshooting, and safety of the equipment. This instruction may be provided in conjunction with the testing requirements identified in paragraph 3.04.

1.07 TOOLS AND SPARE PARTS

A. All special tools required for normal operation and maintenance shall be furnished with the equipment, in accordance with Section 01170.
B. Spare parts shall be furnished as recommended by the manufacturer of the equipment in the manufacturer's operation and maintenance manual.

C. All tools and spare parts shall be packed in containers which are clearly identified as to their contents. All items shall be suitably packed and protected for long periods of storage in accordance with Section 01170.

1.08 EQUAL-PRODUCTS

A. The drawings and specifications are based on a particular arrangement of equipment and piping. Should the Contractor propose to furnish equipment otherwise acceptable to the Government Project Manager, the Contractor shall be responsible for all revisions necessary to incorporate the proposed equipment into the design, at no cost to the Government. The Contractor shall prepare detailed drawings of all revisions to all affected architectural, structural, mechanical, instrumentation, HVAC and plumbing drawings embodying the proposed alternative equipment, for the review and approval of the Government Project Manager.

PART 2: PRODUCTS

2.01 GENERAL

A. The Air Emissions Control System shall be complete consisting of, but not limited to, a thermal oxidation unit, stack, quenching system, wet scrubber, control panel, motor control center, ducting, and all necessary accessories.

B. These Specifications intend to given a general description of required equipment but do not cover all details, which may vary from manufacturer to manufacturer. They are, however, intended to cover the furnishing, delivery, installation, and field testing of all materials, equipment, and apparatus as required. Any additional auxiliary equipment necessary for the proper operation of the proposed installation not mentioned in these Specifications, or not shown on the Drawings, shall be furnished and installed.

C. The material covered by the Specifications is intended to be standard equipment of proven ability and as manufactured by reputable concerns having experience in the production of such equipment. The equipment furnished shall be designed,
constructed, and installed in accordance with best practice and methods and shall operate satisfactorily when installed as shown on the Drawings.

D. All equipment shall be designed and proportioned to have liberal strength, stability, and stiffness and to be especially adapted for the intended service.

E. Equipment bases shall be rigidly and accurately anchored into position, and all necessary foundation bolts, plates, nuts, and washers shall be furnished and installed by the Contractor. All fastening shall be 316 stainless steel. It shall be the responsibility of the contractor to determine the number, size, and location of all anchor bolts to be set in concrete.

F. The equipment shall comply with all applicable OSHA regulations. Heat insulation for personnel protection shall be provided.

G. Brass or stainless-steel nameplates, giving the name of the manufacturers, model number, the rated capacity, and any other pertinent data, shall be attached to each unit.

H. Brass or stainless-steel nameplates, giving the name of the manufacturer, serial number, model number, horsepower, speed, voltage, amperes, and other pertinent data, shall be attached to each motor.

I. Electric motors shall conform to the requirements of Section 16150.

2.02 THERMAL OXIDATION UNIT

A. The thermal oxidation unit shall consist of, but not be limited to, a burner, combustion chamber, inlet duct header, outlet duct manifold, control panel, and controls.
B. Design data and performance requirements for the thermal oxidation unit shall be as indicated below:

1. Air Stream Composition:

<table>
<thead>
<tr>
<th>Volume</th>
<th>1,100 scfm dry air @70°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>54°F</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>100 percent</td>
</tr>
<tr>
<td>Water Mass Flow</td>
<td>50 lb/hr</td>
</tr>
<tr>
<td>Air Mass Flow</td>
<td>4,950 lb/hr</td>
</tr>
</tbody>
</table>

Major Contaminants

<table>
<thead>
<tr>
<th>Compound</th>
<th>Rate (lb/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinyl Chloride</td>
<td>1.4</td>
</tr>
<tr>
<td>Methylene Chloride</td>
<td>0.2</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>1.4</td>
</tr>
<tr>
<td>Trans-1,2-dichloroethene</td>
<td>2.9</td>
</tr>
<tr>
<td>Total Contaminant Rate</td>
<td>5.9 lb/hr</td>
</tr>
<tr>
<td>Heating Value of Contaminants</td>
<td>910 Btu/lb</td>
</tr>
</tbody>
</table>

2. Performance Requirements:

<table>
<thead>
<tr>
<th>Destruction Temperature</th>
<th>1,800°F minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence Time</td>
<td>1.0 second minimum</td>
</tr>
</tbody>
</table>

Destruction efficiency shall be 99.9 percent of vinyl chloride in the waste stream.
3. Operating Conditions

The design of all component parts of the thermal oxidizer shall be based on the following information.

<table>
<thead>
<tr>
<th>Elevation above sea level</th>
<th>500 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating cycle</td>
<td>8,760 hours/year</td>
</tr>
<tr>
<td>Power voltage</td>
<td>460V, 3-phase, 60-Hz</td>
</tr>
<tr>
<td>Control voltage</td>
<td>120V, 1-phase, 60-Hz</td>
</tr>
<tr>
<td>Fuel</td>
<td>No.2 Fuel Oil</td>
</tr>
</tbody>
</table>

C. The burners shall include an IRI- or FM-approved gas train, as well as safety controls.

D. The inlet duct header shall be constructed of carbon steel plate, all welded construction.

E. The outlet duct manifold shall be constructed out of suitable materials to provide protection against corrosion by HCl. The manufacturer shall guarantee that the outlet duct manifold is resistant to corrosion attack by HCl under operating conditions.

F. The thermal oxidation unit shall be provided with a fresh air inlet damper. The purpose of this damper shall be to provide process air to the unit during startup, shutdown, standby, and during periods of low process flow to the unit. The operation of this damper shall be automatic in response to excessive negative pressure at the fan inlet to the unit.

G. The manufacturer shall be responsible for providing a fan capable of delivering sufficient pressure to the 1100 cfm air stream to overcome all pressure drops associated with the thermal oxidation system, quenching system, and scrubbing system.

H. The manufacturer shall provide adequate sized quench recirculation pumps (one operating, one spare) and scrubber recirculation pumps (one operating, one spare).
2.03 QUENCH SYSTEM

A. A quenching system shall be provided to cool the exhaust air stream from the thermal oxidation unit from 1,800°F to approximately 180°F.

B. The quench system shall include a spray contactor and quench tank from which water can be recirculated and two recirculation pumps.

C. The materials of construction shall be resistant to heat up to 1,800°F and resistant to HCl vapors.

D. Instrumentation will include level control to regulate blowdown and makeup water. All necessary instrumentation will be provided to protect quenching system from heat damage.

2.04 AIR SCRUBBER

A. The air scrubber will receive the exhaust gases from the thermal oxidation and quench unit containing 4.3 lb/hr HCl and will remove 95 percent of the HCl. The air scrubber shall be of the wet type using water for absorption of gases. Materials of construction shall be designed to withstand the corrosive nature of the gases and the temperature within the scrubber.

B. The air scrubber shall be a counter-current packed tower with an integral recycle tank for the recirculation of the scrubbing liquid. The minimum packing depth shall be 15 feet. The scrubber shall contain a mist remover. The material of construction shall be suitable for the application specified herein.

C. Makeup water shall be added at a constant flow rate to maintain a water overflow from the scrubber. As fresh makeup water is added, a small amount of the spent scrubbing liquid shall be wasted to the Final Effluent Tank. Treated water will be provided for scrubber makeup as shown on the Drawings.

D. The pH of the recycled scrubbing liquid shall be controlled by dilution with makeup water. The makeup rate of the scrubbing liquid shall be 30 gpm (maximum).
E. The recycle piping shall be CPVC Schedule 80. All valves and other appurtenances shall be CPVC construction.

F. The air scrubber shall include all necessary instrumentation to protect the scrubber from heat damage, in case of an upset condition.

G. The air scrubber shall be designed to support the exhaust stack as specified under this section.

H. The air scrubber shall remove 95 percent by weight of the HCl gaseous contaminants. The efficiency of the mist remover, shall be 98 percent for particles 7 microns or larger.

I. Two scrubber recirculation pumps shall be supplied to circulate sufficient water to achieve HCl emissions.

2.05 EXHAUST STACK

A. The exhaust stack shall be a freestanding unit, with the base serving as the air scrubber.

B. The exhaust stack shall discharge at no less than 30 feet above grade.

C. The exhaust stack discharge velocity shall be 2,000 feet per minute or greater, directed vertically upward.

D. Structural design computations for the scrubber and the exhaust stack shall be submitted to the Government Project Manager for approval.

E. The exhaust stack shall be provided with sampling ports at least eight stack diameters downstream from a flow disturbance. These sampling ports shall allow the traverse points of the stack to be reached according to "The Federal Regulations, Stationary sources 120:0501, Appendix A, Method 1 Sample and Velocity Traverses for Stationary Sources."
2.06 CONTROLS

A. The necessary software and controls will be provided to integrate the Air Emission Control System operation into the overall plant computer control system including automatic startup, shutdown, ramping of incinerator temperature, monitoring of safety interlocks, and fault annunciation.

A temperature indicator/controller shall be provided to monitor and regulate the thermal oxidation unit temperature, complete with high-temperature shutdown and a 4-20 mA output for remote monitoring.

Outputs for system monitoring, as specified in Section 13600, shall be provided as follows:

1. 4-20 ma signal for stack gas monitoring
2. 4-20 ma signal for pH control for Fuel Feed Pumps
3. 4-20 ma signal for remote temperature monitoring
4. Dry contact closure for system status indication
5. Dry contact closure for power loss status indication

B. A NEMA 4 local control panel shall be provided as shown on the Drawings. The panel shall have a minimum of 25 percent free mounting space to permit addition of future control devices.

The control panel shall be completely prewired to terminal strips, and all wiring shall be identified at both ends with designations corresponding to the elementary wiring diagrams. The wire and cable shall be in accordance with the standards of the National Electric Code.

C. Safety controls shall be incorporated in the equipment according to industrial standards. The minimum requirements shall be for an automatic emergency shut down of the well pumps (P-1, P-2, and P-3) in case of an excessive temperature condition or an electrical power outage.
A. Monitoring equipment shall be provided for continuous measurement of total hydrocarbons, carbon monoxide (CO), and oxygen (O2). The monitoring equipment shall be a self-contained unit. Signals for remote monitoring specified in Section 13600 shall be relayed first to the system control panel.

B. The total hydrocarbon analyzer shall be of the oven-heated type with a heated sample pump, flame-out signal, secondary hydrogen gas, and air regulations. The read-out shall be from 0-100 ppm with a 4-20 mA output signal from the control panel for remote recording.

C. The CO analyzer shall be the infrared type with dual ranges of 0-500 ppm and 0-1,000 ppm. The analyzer shall be water-vapor interference-compensated. A 4-20 mA output signal from the control panel for remote monitoring shall be provided.

D. The O2 analyzer shall be a zirconium oxide sensor with a stainless-steel probe which projects into the stack. The analyzer shall have switchable ranges of 0-10 percent and 0-25 percent with a 4-20 mA output signal from the control panel for remote monitoring.

E. Heated sample lines, sample conditioning system, sample mover, and any additional auxiliary equipment necessary for the proper operation of the monitoring equipment shall be provided.

F. All the monitoring equipment shall meet the specifications and test procedures for continuous emission monitoring systems in stationary sources as listed in the Environment Reporter 120:0764, Appendix B, Performance Specification 3 and Performance Specification 4. The monitoring equipment shall also comply with all applicable Federal Regulations not specifically mentioned in these specifications.
PART 3: EXECUTION

3.01 DELIVERY AND STORAGE

A. All equipment shall be crated and delivered to protect against damage during shipment.

B. All parts shall be protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

C. Factory-assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Government Contracting Officer.

D. Flange faces shall be protected from damage. All openings shall be covered to prevent entrance of dirt, water, and debris.

E. Equipment must be mounted on skids or protective framework so constructed as to provide for easy handling by crane or similar device and/or be provided with lifting lugs, cleats, etc., to permit handling by crane. Nozzles, manholes, or other fittings shall not be used for lifting.

3.02 INSTALLATION

A. Installation of equipment shall be in strict accordance with the manufacturer's instructions and recommendations at the locations shown on the drawings. Installation shall include furnishing the required lubricants for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

B. Electrical Connections

1. The Contractor shall provide power fed as shown on the Drawings.
2. All electrical work shall conform to the requirements of Division 16.
C. Piping Connections

1. The Contractor shall be responsible for providing all required piping work for connecting all the equipment supplied and for making field joints.

2. All piping work shall conform with the appropriate Specifications for the project.

3.03 MANUFACTURER'S SERVICE

A. The following shall be done by a qualified serviceman of the manufacturer.

1. Supervision: Checking the installation of all components before power is applied.

2. Check Out: Furnish the services of a factory representative who is fully experienced and qualified in the installation, startup, and operation of the equipment for five 8-hour days to inspect the installation of the equipment and to supervise a test run.

B. The Contractor shall furnish four certified copies of the manufacturer's inspection records to the Government Site Representative.

3.04 TESTING

A. After the air pollution control system has been completely checked out as described above, such tests as necessary to indicate that the performance conforms to the Specifications shall be conducted in the presence of the Government Site Representative.

B. During the tests, each unit shall be operated for not less than 8 hours at the rated capacity.

C. If the unit's performance does not meet the requirements of this Section, the Contractor shall modify, replace, or otherwise increase the system capacity to meet the performance. All additional labor, equipment, etc., required to perform these modifications shall be done at the cost of the Contractor. The performance test shall be redone in full for the modified system.
D. Re-examine the air scrubber packing bed level at least 1 month after startup and add additional packing to compensate for any settling of the bed.

E. Furnish all labor, equipment, and chemicals required for all tests, including retesting, if required.
SECTION 13295
TANKS
T-1 to 16

PART 1  GENERAL

1.01 DESCRIPTION

A. Furnish all labor, materials, equipment, and incidentals required to design, fabricate, construct, and test a 12,700-gallon welded steel closed-top tank (Predecantation Tank, T-1), a 38,000-gallon welded steel closed-top tank (Iron Oxidation/Precipitation Tank, T-2), a 3,400-gallon welded steel closed-top tank (Manganese Oxidation/Precipitation Tank, T-3), a 50-gallon welded steel closed-top tank (Sludge Recycle Tank, T-4), a 3,400-gallon welded closed-top steel tank (Neutralization Tank, T-5), a 950-gallon welded steel open-top tank (Weir Box, T-6), a 200-gallon reinforced fiberglass, open top tank (Biofeeder Tank, T-7), a 2,500-gallon welded steel, open-top tank (Bio-oxidation Tower Sump, T-8), a 11,800-gallon welded steel, open-top tank (Final Effluent Tank, T-9), a 8,200-gallon welded steel closed top tank (Caustic Storage Tank, T-10), a 5,300-gallon welded steel, closed-top tank (Sulfuric Acid Storage Tank, T-11), a 660-gallon, reinforced fiber glass, open-top tank (Biosubstrate Feed Tank, T-12), a 11,800-gallon welded steel, open-top tank (Dirty Backwash Surge Tank, T-13), a 500-gallon, welded steel, open-top tank (Supernatant/Filtrate Recycle Tank, T-14), a 2,500-gallon welded steel horizontal tank (Free Product Storage Tank, T-15) and a 10,600-gallon welded steel, closed-top tank (No. 2 Fuel Oil Storage Tank, T-16).

1.02 RELATED WORK NOT INCLUDED

A. Concrete work is included in Division 3.
B. Painting is included in Division 9.
C. Steel pipe and fittings are included in Section 15061.
D. Vertical shaft process mixers are included in Section 11221.
E. Thermal Insulation is included in Section 15250.
A. The steel tanks shall be fabricated and erected by a firm having at least 5 years successful experience in this type of work and shall be designed in accordance with the latest edition of the American Water Works Association Standard Specification for Welded Steel Elevated Tanks, Standpipes and Reservoirs for Water Storage, D-100, with or without Appendix C. Roof support framing, where applicable, shall be designed in accordance with the current recommendations of the American Institute of Steel Construction with all applicable provisions for lateral bracing. Roof plates shall not be assumed to provide sufficient lateral bracing through friction alone. The roof shall be properly secured to the tank shell.

B. The reinforced fiberglass tank shall be fabricated by a firm having at least 5 years experience in this type of work and shall be manufactured in accordance with ASTM D-3299.

1.04 SUBMITTALS

A. Submit shop drawings where indicated in accordance with Section 01 300.

B. Detail drawings for the tanks, including anchorage and accessories, shall be submitted to the Government Contracting Officer for review before the fabrication or erection is begun. The review will be for layout and geometry. Steel tank drawings shall indicate whether the design is based on AWWA D-100 or, on AWWA D-100 including Appendix C. The Government Contracting Officer’s review does not in any way relieve the Contractor of his responsibility for the accuracy and completeness of his details and design.

C. Design computations for the tanks, including anchorage and other accessories, and including the injection water tank support structure, shall be submitted to the Government Contracting Officer for the records.

D. Submit cleaning and painting systems to the Government Contracting Officer for approval before the fabrication or erection of the tanks is begun.

E. Submit welding procedures to be used to the Government Contracting Officer for approval prior to the beginning of construction. The welding procedure shall include...
joint types to be used, sequence of placing weld metal in the joints, type of electrodes of American Welding Society (AWS) designation, size of electrodes, methods of cleaning (gouging, chipping, grinding, etc.), positioning and type of jigs for automatic welding, wire type and size, type and grade of fluxing materials; volts, amps and speed of travel used for making qualification tests; copies of all required qualification tests; methods by which low hydrogen electrodes, if used, will be stored and heated for moisture control during fabrication; and such other pertinent information as required in Paragraph 101 of the latest AWS Standard Qualification Procedure.

PART 2 PRODUCTS

2.01 DESIGN

A. All tanks and support structures shall be designed to comply with AWWA Specification D-100 and with the dimensions specified herein and shown on the Drawings. Design drawings of the required tanks are attached to this Specification.

B. The Predecanation tank (T-1) shall have a capacity of 12,700 gallons and shall be 14 feet in diameter with a straight shell height of 7 feet and a 60 degree cone bottom.

C. The Iron Oxidation/Precipitation tank (T-2) shall have a capacity of 38,000 gallons and shall be 18 feet in diameter with a straight shell height of 21.5 feet.

D. The Manganese Oxidation/Precipitation tank (T-3) shall have a capacity of 3,400 gallons and shall be 8 feet in diameter with a straight shell height of 10.5 feet.

E. The Sludge Recycle Tank (T-4) shall have a capacity of 50 gallons and shall be 2 feet in diameter with a straight shell height of 3 feet.

F. The Neutralization Tank (T-5) shall have a capacity of 3,400-gallons and shall be 8 feet in diameter with a straight shell height of 10.5 feet.

G. The Weir Box (T-6) shall have a capacity of 950 gallons and shall have the following dimensions 4.5 feet high x 8 feet long x 4.0 wide.

H. The Biofeeder Tank (T-7) shall have a capacity of 200-gallons and shall be 3 feet in diameter with a straight shell height of 5.5 feet.
I. The Bio-Oxidation Tower Sump (T-8) shall have a capacity of 2,500 gallons and shall be 7.0 feet in diameter with a straight shell height of 10.5 feet.

J. The Final Effluent Tank (T-9) shall have a capacity of 11,800 gallons and shall be 12 feet in diameter with a straight shell height of 15.5 feet.

K. The Caustic Storage Tank (T-10) shall have a capacity of 8,200 gallons and shall be 10 feet in diameter with a straight shell height of 14.0 feet.

L. The Sulfuric Acid Storage Tank (T-11) shall have a capacity of 5,300 gallons and shall be 8 feet in diameter with a straight shell height of 14.0 feet.

M. The Biosubstrate Tank (T-12) shall have a capacity of 660 gallon and shall be 5 feet in diameter with a straight shell height of 6 feet.

N. The Dirty Backwash Surge Tank (T-13) shall have a capacity of 11,800 gallons and shall be 12 feet in diameter with a straight shell height of 15.5 feet.

O. The Supernatant/Filtrate Recycle Tank (T-14) shall have a capacity of 550 gallons and shall be 4.0 feet in diameter with a straight shell height of 7.5 feet.

P. The Free Product Storage Tank (T-15) shall have a capacity of 2,500 gallons and shall be a 6 foot diameter horizontal tank with a straight side length of 12 feet.

Q. The No. 2 Fuel Oil Storage Tank (T-16) shall have a capacity of 10,600 gallons and shall be 12 feet in diameter with a straight shell height of 14 feet.

R. All tanks shall be designed for earthquake loads by the fixed percentage methods, seismic Zone 1, in accordance with AWWA Specification. The design shall be governed by the more critical of the load conditions, either earthquake loading or wind loading.

2.02 STEEL TANKS CONSTRUCTION

A. All steel tanks are to be constructed with steel plates of the thicknesses to meet the following conditions:
1. **Horizontal Bottom Plates.** Minimum 1/4 inch, no corrosion allowance required.

2. **Roof Plates.** Minimum 1/4 inch, no corrosion allowance required.

3. **Shell Plates.** A 1/16 inch corrosion allowance shall be added to the thickness determined from the design units, except the minimum thickness, including the corrosion allowance, shall be 1/4 inch.

B. All tank walls shall be of butt welded construction. Welding shall be in accordance with AWWA D-100 and the latest editions of applicable specifications of the AWS. Actual welding procedures to be used shall be submitted to the Government Contracting Officer as specified above for approval prior to the beginning of construction.

### 2.03 FIBERGLASS TANKS CONSTRUCTION

A. The Biofeeder Tank (T-7) and the Biosubstrate Feed Tank (T-12) shall be constructed of fiberglass reinforced plastic (FRP). The tank shall be manufactured of filament wound fiberglass in accordance with ASTM D-3299 standard specification entitled “Fiberglass Wound Glass Fiber - Reinforced Thermoset Resin Chemical-Resistant Tanks” and NBS PS-15-69 for hand lay-up items.

### 2.04 ACCESSORIES

A. The accessories described herein shall be furnished with each tank as listed below. All accessories shall be welded as approved by the NUS Project Manager.

1. **Mixer Support and Mounting Plate.** Mixer support will consist of twin steel I-beams spanning the entire width of the tank. Mixer mounting plate shall match carbon steel 10-inch diameter ANSI Class 150.

2. **Shell Manholes.** Shell manholes shall be of diameter as shown on the Drawings and listed below. Shell manholes shall be located as shown on the Drawings. Shell manholes shall conform to AWWA D-100. Covers shall be hinged on the outside.
3. **Roof Vents.** Roof vents shall be installed on the tanks as listed below, on the roof, at the tank center. The vent shall be designed to pass air at the maximum possible, entering or leaving, rate of flow.

4. **Steel Pipe and Fitting.** Steel pipe and fittings shall conform to Section 15061. Steel pipe shall be used for pipe connections to the tanks and to the points shown on the Drawings. At this point, continuation of the pipes shall be with pipe material as indicated on the Drawings. Connections shall be made by use of transition sleeves sized as necessary.

5. **FRP Pipe and Fitting.** FRP pipe and fittings for the Air Stripper System Sump shall be manufactured with a corrosion resistant material similar to that of the tank itself.

6. **Ladder.** Fixed steel tank ladders shall be provided as shown on the Drawings. Sides of ladders shall be 2 inches by 3/8 inches and rungs shall be 1 inch non-slip square or round bars. Ladder sides shall be set 16 inches apart, on center, and rungs shall be spaced 12 inches on center. Ladder shall be attached to the tank wall a minimum of 9 inches from the wall. Ladders shall conform to all OSHA requirements.

B. Tank accessories shall be provided as follows:

1. **Predecantation Tank.**
   a. One (1) ladder
   b. One (1) 8-inch flanged inlet connection
   c. One (1) 10-Inch flanged outlet connection
   d. One (1) 2-Inch flanged purge connection
   e. Four (4) 1/2-Inch sample connections
   f. One (1) 2-Inch flanged vent connection
2. Iron Oxidation/Precipitation Tank
   a. One (1) Twin I-beam top mixer support
   b. One (1) 12-inch mixer mounting flange
   c. One (1) 24-inch shell manway
   d. One (1) 10-inch flanged inlet connection
   e. One (1) 8-inch flanged outlet connection
   f. One (1) 3-inch air diffusion header with flanged connection
   g. One (1) 3-inch flanged vent connection
   h. One (1) 4-inch flanged sludge recycle connection
   i. One (1) 2-inch flanged caustic feed connection

3. Manganese Oxidation/Precipitation Tank
   a. Four (4) Anti-vortex baffles
   b. One (1) 24-inch shell manway
   c. One (1) Twin I-beam top mixer support
   d. One (1) 12-inch mixer mounting flange
   e. One (1) 8-inch flanged inlet connection
   f. One (1) 10-inch flanged outlet connection
   g. One (1) 2-inch flanged vent connection

4. Sludge Recycle Tank
   a. Four (4) anti-vortex baffles
   b. One (1) Twin I-beam top mixer support
   c. One (1) 6-inch mixer mounting flange
   d. One (1) 2-inch flanged inlet connection
   e. One (1) 4-inch flanged outlet connection
   f. One (1) 1-inch dispersant feed connection
   g. One (1) 1/2-inch caustic feed connection

5. Neutralization Tank
   a. One (1) Twin I-beam top mixer support
   b. One (1) 12-inch mixer mounting flange
   c. One (1) 24-inch shell manway
   d. One (1) 10-inch flanged inlet connection
   e. One (1) 8-inch flanged outlet connection
   f. One (1) 1/2-inch sulfuric acid feed connection
   g. One (1) 1/2-inch dispersant feed connection
6. Weir Box
   a. One (1) 8-inch flanged inlet connection
   b. Three (3) 6-inch flanged outlet connection

7. Biofeeder Tank
   a. One (1) 3/4-inch outlet connection
   b. One (1) 1-inch air diffusion header

8. Bio-Oxydation Tower Sump
   a. One (1) 8-inch flanged outlet connection
   b. One (1) 1-inch level transmitter connection

9. Final Effluent Tank
   a. One (1) 8-inch flanged outlet connection
   b. One (1) 8-inch flanged backwash outlet connection
   c. One (1) 1-inch level transmitter connection

10. Caustic Storage Tank
    a. One (1) 1/2-inch inlet connection
    b. One (1) 1-inch outlet connection
    c. One (1) 2-inch flanged vent connection
    d. One (1) 1-inch level transmitter connection

11. Sulfuric Acid Storage Tank
    a. One (1) 2-inch flanged inlet connection
    b. One (1) 1/2-inch outlet connection
    c. One (1) 2-inch flanged vent connection
    d. One (1) 1-inch level transmitter connection

12. Biosubstrate Feed Tank
    a. One (1) 1/2-inch outlet connection

13. Dirty Backwash Surge Tank
    a. One (1) Twin I-beam top mixer support
    b. One (1) 3-inch flanged outlet connection
14. Supernatant/Filtrate Recycle Tank
   a. One (1) 3-inch flanged inlet connection
   b. One (1) 2-inch flanged inlet connection
   c. One (1) 2-inch flanged outlet connection

15. Free Product Storage Tank
   a. One (1) ladder
   b. One (1) 24-inch top manway
   c. One (1) 2-inch flanged inlet connection
   d. One (1) 2-inch flanged outlet connection
   e. One (1) 1/2-inch flanged vent connection
   f. Two (2) 1/2-inch side level gauge connections

16. No. 2 Fuel Oil Storage Tank
   a. One (1) 2-inch flanged inlet connection
   b. One (1) 1/2-inch outlet connection
   c. One (1) 2-inch flanged vent connection
   d. One (1) 1-inch level transmitter connection

PART 3 EXECUTION

3.01 FABRICATION AND ERECTION

A. Fabricate and erect the steel tanks and accessories in accordance with AWWA
   Standard D-100.

B. The underside of roof plates shall be seal welded if overlapping joints are used.

3.02 INSPECTION OF WELDS

A. After welding has been completed have at least one spot radiograph taken in the field
   on the four sides of every plate below the overflow elevation. The spot radiographs
   required by the AWWA Standard D-100 may be considered as a part of the above
   requirements.

B. All bottom plates shall be tested by the air pressure or vacuum method in accordance
   with AWWA Standard D-100.
C. Submit a report on the X-ray inspection to the Government Contracting Officer.

3.03 FOUNDATION

A. Tank foundations shall be constructed in accordance with the Contract Drawings. Tank anchorage to foundation shall be as recommended by the tank manufacturer.

3.04 GROUTING

A. The Contractor shall grout between the top of the foundation and the bottom of the steel tanks as shown on the Drawings with non-shrink, non-metallic grout.

3.05 CLEANING AND TESTING

A. Upon completion of all work and just prior to placing each tank in service, the Contractor shall remove all debris from within the tank and shall carefully sweep the floors of all loose dirt and debris to the satisfaction of the Government Site Representative.

B. The tanks shall then be filled to one-half capacity and allowed to stand for 24 hours. This step shall then be repeated for three-fourths and full capacities.

C. Any leaks which are disclosed by this test shall be repaired by gouging out defective areas and rewelding. No repair work shall be done on any joint unless the water in the tank is at least 2 feet below the point being repaired. Any point damaged by repairs shall be properly restored.

3.06 PAINTING

A. As specified in Division 9.

END OF SECTION
SECTION 13610
INSTRUMENTATION PRODUCTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. General Requirements

1. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals which are established standards for the water and wastewater industries.

2. All electronic instrumentation shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mA (milliamperes direct current) unless otherwise noted. However, signals between instruments within the same panel or cabinet may be 1-5 V.DC (volts direct current), or the like.

3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based on signals will be allowed.

4. All instruments shall be provided with the manufacturers standard mounting hardware.

5. All indicators and recorder readouts shall be linear in process units.

6. All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent.

7. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 100 percent relative humidity. The field mounted
equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

8. All equipment cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

B. Electrical

1. All equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 117 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

2. All analog transmitter and controller outputs shall be 4-20 mA into a load of 0-750 ohms, unless specifically noted otherwise.

3. All switches shall have double-pole double-throw contacts rated at a minimum of 600 VA, unless specifically noted otherwise.

4. Materials and equipment used shall be U.L. approved where ever such approved equipment and materials are available.

5. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

PART 2 PRODUCTS

2.01 FIELD MOUNTED INSTRUMENTS

A. Level Indicating Transmitter (Differential Pressure)
Tag Number: LIT-1, LIT-3, LIT-4, LIT-7, LIT-8 and LIT-9

1. Type:
   a. Differential Pressure (or Gauge Pressure) Actuated
   b. Flange mounted, extended diaphragm
   c. Electronic Output
   d. Manufacturer: FOXBORO, model 847EF-A11SKA6-A or approved equal

2. Operation:
   a. Purpose: To sense liquid level variations by means of differential pressure (or
gauge pressure) and produce a standard current output signal linear with
level.
   b. Sensing Element: Differential pressure cell.
   c. Indicator: Integrally mounted.

3. Functional:
   a. Static Pressure Limits: 1,000 psig
   b. Power Supply: DC (24-30V DC)
   c. Output: 4-20 mA DC
   d. Independent span and zero adjustments
   e. Integral range elevation and suppression adjustments

4. Physical:
   a. Wetted Parts: 316 SS
   b. Body Material: 316 SS
   c. Electronics Housing: NEMA 4X
   d. Connections: Flange - 2 inch, ANSI class 150, carbon steel

5. Performance:
   a. Accuracy: Plus or minus .25 percent of span (or better)
   b. Indicator Accuracy: Plus or minus 2.0 percent of span (or better)
6. Process Fluid Data:
   a. Fluid: Water
   b. Fluid Temperature: 55° F
   c. Fluid Specific Gravity: 1.0

7. Instrument Calibrated Range:
   LIT-1: (0-258" H₂O) = 4-20MA
   LIT-3: (0-126" H₂O) = 4-20MA
   LIT-4: (0-186" H₂O) = 4-20MA
   LIT-7: (0-168" H₂O) = 4-20MA
   LIT-8: (0-168" H₂O) = 4-20MA
   LIT-9: (0-168" H₂O) = 4-20MA

B. Level Indicating Transmitter (Differential Pressure)

Tag Number: LT-4

1. Type:
   a. Differential pressure (or gauge pressure) actuated
   b. Flange mounted
   c. Electronic output
   d. Manufacturer: FOXBORO, Model 827DF-IS1NMKA1-A or approved equal

2. Operation:
   a. Purpose: To sense liquid level variations by means of differential pressure or (gauge pressure) and produce a standard current output signal linear with level.
   b. Sensing element: Differential pressure cell
   c. Indicator: Integrally mounted
3. Functional:
   a. Static Pressure Limits: 1,000 psig or better
   b. Power Supply: DC (24-30 V DC)
   c. Output: 4-20mA DC
   d. Independent span and zero adjustments

4. Physical:
   a. Wetted Parts: 316 SS
   b. Body Material: 316 SS
   c. Electronics Housing: NEMA 4X
   d. Connections: Flange - 3 inches ANSI, Class 150, carbon steel

5. Performance:
   a. Accuracy: Plus or minus 0.25 percent of span (or better)
   b. Indicator Accuracy: Plus or minus 2.0 percent of span (or better)

6. Process Fluid Data:
   a. Fluid: Water
   b. Fluid Temperature: 55° F
   c. Fluid Specific Gravity: 1.0

7. Instrument Calibrated Range:
   
   \((0-48'' H_2O) = (4-20 MA)\)
C. Level Switch (High and Low) Point Type

Tag Number: LSL-2 and LSH-2
LSL-5 and LSH-5

1. Level switch to have admittance type sensing element.

2. Electronic unit shall be a solid state radio frequency admittance transmitter with circuitry designed to ignore errors generated by coating build-up on the sensing element. Sensor electronics shall be integrally mounted and housed in a waterproof, NEMA 4X enclosure; power required shall be 120 VAC, 60 Hz.

3. Level switch contact output shall be DPDT type. Contact rating shall be 5 amp non-inductive load, 3A inductive load at 120 VAC.

4. Level switch operation shall include an adjustable time delay (0-90 sec).

5. Sensing element and mounting connections shall have all metal parts (stainless steel) with sensing element to be stainless steel/teflon.

6. Ambient temperature range of the electronics shall be -40 °F to 140°F.

7. Process Fluid Data:
   a. Fluid: Dirty water
   b. Fluid Temperature: 55°F
   c. Fluid Conductivity: Approximately equal to that of water (well water)

8. Instrument Range Data:
   a. LSL-2 and LSH-2
      - Tank Height: 10'6"
      - Low Level Switch Trip Point: 2'0" from tank bottom
      - High Level Switch Trip Point: 9'6" from tank bottom
      - LSL-3 Probe Length: 8'6"
      - LSH-3 Probe Length: 1'0"
b. LSL-5 and LSH-5
   - Tank Height: 15'6"
   - Low Level Switch Trip Point: 2'0" from tank bottom
   - High Level Switch Trip Point: 14'6" from tank bottom
   - LSL-5 Probe Length: 13'6"
   - LSH-5 Probe Length: 1'0"

c. Tank or Sump Construction
   - LSL-2 and LSH-2
     - Tank Material: stainless steel
   - LSL-5 and LSH-5
     - Tank Material: stainless steel

d. Probe Orientation (Mounting):
   - Vertical orientation inserted from top of tank or sump.

e. Manufacturer and Model Number:
   - DREXELBROOK Model Number: 506-6000-2 GIPI LCS or approved equal
     with Model #406-6002-E integral electronic unit with heavy duty cote
     shield circuitry and with 700-202-2 sensing element
     Qty: (2)
     (Note: Sensor Insertion Lengths)
   Note: Level switches LSL-5 and LSH-5 are mercury float type switches and
   are supplied with the sump pump.

D. Pressure Switch:

Tag Number: PSL-6 and DPSL-2-F

1. Type:

   a. Pressure (or differential pressure) actuated
   b. SPDT
2. Operation:

a. Purpose: To provide a contact output at a predetermined pressure value (or differential pressure value).
b. Operating Principle: Diaphragm pressure element coupled to an assembly piston/spring and switch assembly.

3. Functional:

a. Contact Rating: 15 amp at 250 volts AC (max).
c. Average Differential: 3 to 10 percent of range between "make and brake" of switch.

4. Physical:

b. Case Material: Cast aluminum.
c. Process Connection: 1/2-inch NPT.
d. Enclosure rating: NEMA 4X.
e. Diaphragm and o-ring material: Teflon coated polyamide diaphragm and BUNA-N o-ring.

5. Process Fluid Data:

a. PSL-6
   - Service - Air Pressure (Low)
   - Fluid - Air
   - Fluid Temperature - 70° F Nominal
   - Maximum Line Pressure - 100 PSIG

b. DPSH-2-F:
   - Service - Deep Bed Filter Differential Pressure (High)
   - Fluid - Water
   - Fluid Temperature - 55°-F
   - Fluid Specific Gravity - 1.0
   - Maximum Line Pressure - 45 PSIG
6. Instrument Range Data:

a. PSL-6: Low Pressure Trip Point - 60 PSIG
b. DPSH-2-F: High Differential Pressure Trip Point-20 PSIG

7. Manufacturer and Model No.:

a. PSL-6: SOR, Inc., Model No. 6NN-H3-N4-B2A-PP or approved equal
b. DPSH-2-F: SOR, Inc., Model No. 17RB-K3-N4-B2A-PP or approved equal

E. Magnetic Flow Tube/Electronic Transmitter

Tag Number: FE-1 and FE-2

1. Flow Tube:

a. Type:
   - Magnetic flow sensing
   - Manufacturer: FOXBORO Model 8008-BTR-A or approved equal

b. Functional:
   - Designed to measure flow rate of electrically conductive liquids and produce a measurement signal directly proportional to the volumetric flow.
   - Power Supply: (Supplied by transmitter unit).

c. Physical:
   - Nominal Flow Tube Size: 8 inch
   - Flow Tube Lining Material: PTFE
   - Mounting: Wafer installed between (2) ANSI Class 150 flanges
   - Mounting hardware to be included.
   - Flow Tube Housing Material: Ductile iron
   - Transmitter Mounting: remote
   - Enclosure Classification: NEMA 4
d. Performance:
- Accuracy: (See transmitter section for system accuracy requirements)
- Temperature Limits: -4 to 158° F ambient
- Relative Humidity Limits: 5 and 90 percent

2. Flow Transmitter:

Tag Number: FIT-1 and FIT-2

a. Type:
- Magnetic flow meter low level converter and exciter
- Electronic output
- Microprocessor based
- Manufacturer: FIT-1 FOXBORO Model 8000-PA10-T or approved equal
  FIT-2 FOXBORO Model 8000-PA10 or approved equal

b. Functional:
- Transmitter to use pulse DC technique to excite magnetic flow tube coils and convert low level pulsed DC signal voltage to a current output signal (4-20 mA) and (pulsed output - FIT-1 only).
- Power Supply: 120 VAC, 60 Hz
- Minimum signal lock (low-flow cutout).
- Local flow rate indication in percent of full range or in engineering units.
- Local flow rate totalizer indication (battery backed up) (FIT-1 only).
- Output: 4-20 mA and (pulse - FIT-1 only).
- Diagnostics: microprocessor based system self test
- Calibration: microprocessor based

c. Physical:
- Mounting: pipe
- Housing: cast aluminum
- Enclosure classification - NEMA 4X
d. Performance

- Accuracy

  - (Pulse Output) ± 1.0 percent of flow rate (over meter operating range).

  - (Current Output) ± 1.0 percent of flow rate (over meter operating range) plus 0.1 of the upper range value.

  - Temperature Limits: -4 to 131°F ambient

  - Relative Humidity Limits: 5 and 90 percent

F. Flow Switch: (Liquid or Gas (Air) Low Flow)

Tag Number: FSL 2-B

1. Type:

   a. Thermally actuated flow switch
   b. SPDT relay contacts
   c. Field adjustable trip point

2. Operation:

   a. Purpose: to provide a contact output when flow rate falls below a predetermined value.

   b. Detects variations in flow velocity by sensing changes in the heat transfer properties of the flowing medium.

   c. Sensor consists of (2) two matched resistor temperature sensors in stainless steel thermowell and (1) one low powered heating element in a third stainless steel thermowell.
3. Functional:
   a. Contact Rating: 2 amps (resistive) at 115 VAC
   b. Relay coil de-energized at no flow conditions.
   c. Field adjustable switch point: 5 mV deadband
   d. Required Power Supply: 120 VAC 60 Hz

4. Performance
   a. Repeatability: 0.5 to 1.0 percent of full range signal.
   b. Operating Temperatures (sensor head): 100°F to 350°F
   c. Operating Temperatures (electronic): 50°F to 150°F
   d. Operating Pressure (max.): 4,000 psig
   e. Enclosure: weatherproof

5. Physical
   a. Process Connection: 1 inch MNPT
   b. Process Wetted Parts: 316 SS
   c. Pipe Orientation: horizontal-side mounted
   d. 2 inch insertion length

6. Process Fluid Data:
   a. Fluid - Air
   b. Fluid Temperature - 70°F
   c. Maximum Flow - 165 SCFM
   d. Line Size - 4"

7. Instrument Range
   a. Low-Flow Trip Point - 90 SCFM

8. Manufacturer and Model Number
   a. FCI Model No. 12-64-4-1"-U-S-G-G-H-5181 or approved equal
G. Pressure Gauges

- 4-1/2" Dial Size, Solid Front Phenol Black Case, Grade A Phosphor Bronze Bourdon Tube, 1/2" Lower Connection Ashcroft Model No. 45-1279AS.

- Pressure Gauge Diaphragm Seal 1/2" NPT Process Conn., 316SS Diaphragm and Bottom Housing, Glycerine Fill Ashcroft Model No. 50-100SS-04T-CG.

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<th>Pressure (PSIG)</th>
<th>Valve No.</th>
<th>Gauge Range</th>
<th>Equipment Tag No.</th>
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<td>Yes</td>
<td>Dirty backwash</td>
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<td>PI 135</td>
<td>7</td>
<td>V331</td>
<td>0-15</td>
<td>A88</td>
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<td>A89</td>
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<td>V294</td>
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<td>0-30</td>
<td>P45</td>
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<td>V312</td>
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<td>Yes</td>
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2.02 PANEL MOUNTED INSTRUMENTS

A. CRT Operator Interface Terminal

1. Type:
   a. Keypad terminal with color CRT.
   b. Hardwired panel device replacement.
   c. Enclosure Classification: NEMA 12, 13, 4X
   d. Microprocessor based/extended battery backup.
   e. Manufacturer: ALLEN-BRADLEY (Panel View) Model No. 2711-KC1 or approved equal

2. Operation:
   a. CRT-based operator graphic screens.
   b. CRT-based local controller face plate displays.
   c. CRT-based alarm indication and acknowledgement.
   d. CRT-based alarm history function.
   e. Alarm printout via RS232 port.
   f. Motor "RUN" indication via graphic screens.

3. Functional:
   a. Screen development software to run on IBM PC (min. 640 K RAM) or compatible.
   b. Development software to be menu driven.
   c. PLC Interface: ALLEN BRADLEY 1771 remote I/O communications or equal.
   d. Development software interface: Download software from IBM PC VIA RS232 Serial communications port.
e. Alarm Printer Interface: RS232 Serial communications port.

f. Key Pad Arrangement: 21 user configurable function Keys, Numeric Keypad 0-9, Dec. Pt., Minus sign; Backspace and enter special functions, four direction cursor arrows, home key, select, cancel, raise and lower.

4. Physical:

a. Mounting: Panel Front
b. 19” x 14”
c. CRT Display Size: 12 inches diagonal

5. Performance:

a. Memory: 64 KC mos with extended battery back-up (7 years at 122°F ambient)
b. Temperature Limits: 32°F to 122°F
c. Relative Operating Humidity: 95 percent max at (32-86°F)
d. Operating Altitude: 10,000 ft. max.
e. Remote I/O communication baud rate: 57.6k or 115.2k
f. Power Supply: 120 VAC, 60 Hz
g. Power Consumption: 80 watts max.

B. Trend Recorder

1. Type:

a. (2) channel.
b. Microprocessor based.
c. Thermal print head (1/4 percent resolution) (414 dots).
d. Vertical scale (prints user configurable chart).
e. 4 inch strip chart.
f. Manufacturer: BRISTOL BABCOCK Model No. SLC 3711 or approved equal.
2. Operation
   a. Microprocessor based thermal printing instrument.

3. Functional
   a. Inputs: (4-20mA DC into 250 ohms or 1-5 V DC into 3 meg ohms.
   b. Remote control chart speed change (digital inputs).
   c. (2) selectable chart speeds from range of values (0 to 120 inches/hr).
   d. Power Required: (23.5-28) volts DC, 1.8 amps max and less than 10 mV ripple.

4. Physical:
   a. Case Size: (front) 5.67 inches x 5.67 inches, (length) 21 inches
   b. Mounting: flush panel type
   c. Chart Paper: roll type, no holes, width - 4.34 inches, length - 80 feet

5. Performance
   a. Input Resolution: 1.35 mV referred to input
   b. Chart Resolution: 1/4 percent full scale (1 dot in 400)
   c. Execution Time: every 300 msec
   d. Temperature Limits: 0-50°C
   e. Humidity Limits: 10-95 percent relative humidity, non condensing
   f. Environment: control room quality as defined in ISA S51.1

2.03 PROGRAMMABLE CONTROLLER EQUIPMENT

A. Processor

1. Type:
   a. Single (I/O) slot processor.
   b. Base memory: 13 K words (21 K max).
   c. I/O capability: 1024 (any mix).
   d. Operating modes: scanner or adapter.
e. Programming language: ladder logic and special instruction set functions plus sequential function chart programming.

f. Manufacturer: ALLEN-BRADLEY PLC 5/25 or approved equal.

2. Functional

a. Communications:
   1. Scanner (local and remote I/O).
   2. Adapter (slave to a supervisory processor).
   3. Peer to peer (peer communications).

b. Programming interface: via ALLEN-BRADLEY 1784-T 50 terminal, or T45 laptop terminal.

c. PID control loops: ISA equation or independent gains equation (selectable).

d. Number of PID loops available: approximately 20 (1) one second update control loops (program overall scan time dependent and control loop scan requirements dependent).

e. Memory: battery backed CMOS RAM

f. Power requirements: 2.5 amps (I/O chassis backplane)

3. Performance

a. Program Scan: 2 ms/k (minimum)

b. I/O Scan: 1 ms (minimum)

c. Temperature Limits: 32°F to 140°F (operating).

d. Relative Humidity: 5 to 95 percent (non-condensing).

e. Memory Battery Backup: self-contained lithium battery (1-year memory life without power).
B. I/O Chassis and Modules

1. General

a. Universal I/O chassis (ALLEN BRADLEY 1771 or equal) (refer to PLC system block diagram for I/O rack configuration and module allocation).

b. Rack Power Supplies: to supply 5 VDC at 16A for I/O chassis backplane (ALLEN-BRADLEY 1771-P7 or approved equal).

c. Universal I/O to consist of the following module types:

- 120 VAC input (16 point) 1771-IAD
- 120 VAC isolated output (6 point) 1771-OD
- 120 VAC output (16 point) 1771-OAD
- 4-20MA input (8 differential inputs) 1771-IFE
- 4-20MA output (4 point) 1771-OFE

d. I/O Rack Communications:

- Local I/O rack.
- Remote I/O rack (via 1771-ASB remote I/O adapter).

2. Performance (I/O Modules)

a. Temperature Limits: 32 to 140°F (operating).

b. Relative Humidity: 5 to 95 percent (non-condensing).

C. Alarm Printer

1. Type:

a. Dot matrix printer (9 pin).

b. 136 column.

c. Manufacturer: EPSON Model No. FX-1050 or approved equal
2. Functional:
   a. Tractor Feed: built in (push)
   b. Draft mode or near letter quality (NLQ) mode: selectable
   c. Buffer size: 8K
   d. Communications Interface: serial (RS232C)
   e. Resident Fonts: Roman and San Serif
   f. Power Required: 120 VAC, 60 Hz

3. Performance:
   a. Draft Mode Speed: 290 characters per second
   b. NLQ Mode Speed: 54 characters per second
   c. Mean Time between Failure: 6,000 hrs

4. Physical:
   a. Overall Dimensions: 24(W) x 16(L) x 7(H) inches (approximate)

2.04 POWER CONDITIONING EQUIPMENT

A. Application: to provide regulated/surge protected 120 VAC power for PLC processor, I/O rack power supplies, CRT operator terminal, and 24 VDC instrument power supply.

B. Type: voltage regulation and ultra-isolation, 120 VAC single phase 60 Hz input, 120 VAC single phase 60 Hz output.

C. Capacity (maximum VA output): 150 percent of connected load (refer to schematic diagram for unit capacity).

D. Performance

1. Output Waveform: sinusoidal output wave-shape containing less than 3 percent harmonic distortion.

2. Noise Rejection: greater than 60 DB transverse noise rejection.
3. Regulation: input line variation of ±15 percent regulated to ±3 percent on output.

4. UL listed.

2.05 INSTRUMENT LOOP POWER SUPPLY

A. Application: to provide 24 VDC power to field instruments and trend recorder.

B. Type:

1. Regulated.
2. Short circuit proof with automatic recovery (electronic current limiting).
3. 24 V DC output voltage.
4. Remote voltage sensing terminals.
5. Polarity: floating
6. Supply Voltage: 120 VAC 60 Hz

C. Capacity (Amp Output):

1. 150 percent of connected load (refer to schematic diagram for unit capacity).

D. Performance:

1. Regulation (load): ±0.005 percent
2. Regulation (line): ±0.005 percent
3. Ripple: 0.25 mV rms
4. Operating Temperature Limits: -20 to 71°C
5. Response time: less than 20 microseconds

2.06 CONTROL PANELS

A. All panels furnished under this section shall be of the arrangement, design, and size as shown on the Contract Drawings and as specified herein. Access doors or panels shall have continuous stainless steel hinges and approved latching or fastening means to allow access. Fabrication shall be of 11 ga. thick, sheet steel or stainless steel, suitably braced internally for structural rigidity and strength.
Front panels or sections containing instruments shall be not less than 7 ga. thick stretcher leveled sheet steel, stainless steel or 1/4 in thick anodized aluminum, reinforced to prevent warping or distortion. All sections shall be descaled, degreased, filled, ground and finished. The enclosure when fabricated of steel shall be finished with two rust-resistant phosphate prime coats and two air dry silicone alkyd finish coats of enamel which shall be applied by either the hot air spray or conventional cold spray methods. The final finish shall be smooth, free of runs, and uniform in tone and thickness. Unless otherwise noted, the color to be used shall be selected by the Owner from color chips supplied by the panel manufacturer. Brushed anodized aluminum, stainless steel and FRP Panels will not require a paint finish.

B. All pneumatic tubing running from the field to the panel shall be Type L. hard drawn copper instrument tubing. Pneumatic instrument air tubing run within the panel shall be 1/4 inch copper or plastic piping routed and tied neatly in bundles. Pneumatic instruments are to be mounted and piped to bulkhead fittings and properly identified to provide ease of field connection. Provide air header. Each instrument shall be provided with individual shut-off valves. Provide test connections within the panel for facilitate testing and calibration.

C. All conductors running from the field to the control panel shall be a single, continuous length, without splices, except at approved junction boxes. The junction boxes shall have terminal blocks with 20 percent spares in addition to terminals for all wires including spare wires. Special care shall be exercised to carry grounding lines through such junction boxes with the least possible resistance. Multi-conductor cable may be used between junction boxes and control panels.

D. All panel equipment shall be mounted and wired on or within the cabinet. Wiring shall comply with latest ANSI and 1990 National Electric Codes. All wiring within the panel shall be grouped together with harnesses or ducts and secured to the structure. All wiring shall be numbered in accordance with the numbering system used on the wiring/connection diagrams. Wiring and connection diagrams shall conform to ISA 55.4 Instrument Loop Diagrams and shall be submitted by the manufacturer as part of the shop drawings for approval of the Engineer. Power and low voltage DC signal wiring shall be routed in separate wire ways. Crossing of the two system wires shall be at right angles. Parallel troughs of different systems shall be separated by a minimum of 12-in. Power wire shall be 14 AWG type THWN stranded insulated for not less than
600 volts unless specified otherwise. Wire color shall be, Line Power - Black; Neutral or common - White; AC Control - Red, DC Control - Blue; Equipment or Chassis Ground - Green; specified externally powered circuits - Orange. Graphic light wiring (24 volt) maximum at the lamp socket may be 22 AWG if properly fuse protected and terminating in a terminal block capable of accepting No. 14 AWG field wiring. All wiring shall terminate in a master terminal board, rigid type and numbered. The master terminal board shall have a minimum of 25 percent spares. Terminal blocks shall be arranged in vertical rows and separated into groups. (Power, AC control, DC signal, alarm, and graphic). Terminal blocks shall be barrier type with the appropriate voltage rating (600 volts minimum). They shall be the raised channel mounted type. Wiring trough for supporting internal wiring shall be plastic type with snap on covers. The side walls shall be open top type to permit wire changing without disconnecting. Wire connectors shall be the hook fork type with non-insulated barrel for crimp type compression connection to the wire. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers. Terminal strips shall be provided for the purpose of connecting all control and signal wiring. Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal block row shall not be used for internal wiring. The field wiring side of the terminal shall not be within 6-in of the side panel or adjacent terminal. Wiring troughs shall not be filled to more than 60 percent visible fill. Wiring trough covers shall be match marked to identify placement. If component identification is shown on covers for visibility, the ID shall also appear on the mounting sub-panel. A plug-in header with convenience outlets and flexible plug-in leads shall be supplied for instrument power supplies. A spare convenience outlet shall be provided. An overhead internal light shall be provided. Front layout shall be submitted to the Contracting Officer for approval.

E. All wiring to hand switches and the like which are live circuits independent of the panel's normal circuit breaker protection shall be clearly identified as such.

F. All relays not provided under Division 16 and required for properly completing the control function defined in this section or shown on the Contract Drawings shall be provided under this section. For example, pilot lights (both ON and OFF) will receive a single pair of wires for both conditions. As a result a relay is required to provide inputs to both pilot lights.
G. These relays shall be mounted in their respective control panel and clearly identified as being live circuits independent of the panel's normal circuit breaker protection.

H. Nameplates shall be provided for all flush mounted equipment. The nameplates shall be approximately 1-in by 3-in constructed of black and white laminated, phenolic material having engraved letters approximately 1/4-in high, extending through the white face into the black layer. Nameplates may be omitted if a nameplate of approximately the same dimension is more conveniently and suitably located on the instrument door or face. Nameplates shall be attached to panels by self tapping screws.

I. Print storage pockets shall be provided on the inside of each panel. Its size shall be of sufficient size to hold all of the prints required to service the equipment. Reduced drawings shall be provided to be stored in these pockets.

J. Where noted on the panel detail, the instrument panels shall include, an air to air heat exchanger or air conditioning unit for removal of panel interior equipment generated heat. This unit to be thermostatically controlled. The unit to be sized for 150 percent of actual heat load for specified panel size. Heat exchanger/air conditioning unit to have manual power disconnecting means provided in panel interior. Air intake louvers shall be fully baffled with filters.

K. The instrument panel shall be factory-tested prior to shipment. Field installation by the Contractor shall consist only of setting the panel in place and making necessary electrical and instrument air connections. Inspection at the plant by the Government is required. A ten working day notification prior to shipment is required.

L. Touch-up Paint. One (1) gallon in one-quart containers of touch-up paint shall be furnished for each type and color used for instrument cabinet finish coats.

2.07 MISCELLANEOUS PANEL COMPONENTS

A. All components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect
equipment from vibration. Components mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices. All internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the Contract Drawings, specifications, and supplier's data.

1. Push Buttons:

The push buttons shall be heavy-duty, oil tight, with momentary contacts. Switches shall be supplied with the number of poles required for the application, an escutcheon plate, and contacts rated for 10 amperes at 120 volts AC.

2. Relays:

Relays shall be double pole, double throw, octal plug in type with a transparent dust cover. The relay shall be equipped with an indicating light to indicate when its coil is energized. The relays shall have 5 amperes 120 volt AC contacts. The mechanical life of the relay shall be 10,000,000 operations minimum.

3. Timers:

Timers shall be plug in type with a dust and moisture resistance case. The timers shall be of the multi-range/ analog or digital type with selectable ranges, between 1 second and 10 hours full scale. The output contacts shall be rated at 2.5 amperes 120 volt AC minimum. The timer shall have a "timing in progress" indication. The mechanical life shall be 10,000,000 operations minimum.

4. Hand Switches:

2-inch Square Type - Selector switches shall be of the illuminated multiple-lamp, oil tight type with square-shape display windows and removable contact blocks. The units shall be approximately 2-1/2 inches square, and shall be divided into as many as four separate lightable quadrants. The lights shall be equipped with reduced voltage transformers or resistors depending on primary power source and lamps with a 15,000 hour minimum life. Contact blocks shall be heavy-duty with fine silver, butting-type contacts. Contact rating shall be 10 amps continuous current at 120 volts AC.
Contact blocks for electronic duty shall contain sliding gold contacts for solid-state millivolt and milliamp dry circuits. Contact rating shall be 1 amp resistive load at 28 volts DC.

5. Except where the 2-inch square type are specifically required the following type shall be provided:

Rotary selector switches shall be heavy duty oil resistant, with the number of poles and number of positions as required. Switches shall have a pistol grip handle and be of the maintained contact type rated for 10 amps at 120 volts AC. The switches required for "electronic duty" shall have low, stable, contact resistance and gold contacts. Provide make-before-break bridging contacts where required.

6. Pilot Lights:

Compact multi-light indicating lights shall be provided as shown on the graphic and cabinets. Units shall be approximately 1-in diameter with a minimum of three colors. Bulbs shall be of the reduced voltage type to have a life exceeding 10,000 hours and allow relamping from the front. Lens shall be engraved per the Contract Drawings and have the appropriate colors. Amber lights shall be alarm and be activated from the separately mounted annunciator system.

2.08 CONTRACTOR SUPPLIED PROGRAMMING SERVICES

A. System Description (Overview)

The PLC based control system for the neargradient Groundwater Remediation System will consist of an Allen-Bradley PLC 5/25 processor, three (3) 16-slot universal I/O racks and associated power supplies, a color CRT based man-machine interface (Allen-Bradley panel view), and an alarm printer. (Refer to PLC block diagram drawing 0224-6D119 and 0224-6D120.) The PLC based control system will supply the control functions indicated on the P&ID drawings and described in the process functional description (refer to the design document for neargradient Groundwater Remediation System).

The deep bed filter system will be supplied by a third party and the software functionality provided by the PLC control system will be implemented per the control
logic diagrams provided by the third party equipment vendor. (Refer to the functional
description in the design document for a general description of the required control
system functions for the deep bed filters).

Operator interface functions provided by the Allen-Bradley panel view will include, at
the minimum, the following:

1. Process graphic screen displays with process measurement data update points and
   pump/motor run status indication.

2. Process summary screens (includes process measurements and run status).

3. Alarm indication/alarm summary.

4. 3-mode controller interface screens (face plate displays).

5. Process measurement faceplate displays.

6. Main menu display and softfunction key screen access.

7. Alarm message record/hardcopy via alarm printer.

The CRT based man-machine interface will provide a run status and fault status
indication for the system motors. There will be no start/stop or auto/manual operator
initiated functions for these motors available at the man-machine interface. All these
functions will be provided locally at the equipment.

The Allen-Bradley panel view will be addressed as an I/O rack attached to the PLC 5/25
remote I/O communications.

Provisions are to be made (i.e., included in the software functionality) for the
transmission of the control system alarms and the PLC system fault/status information
to a remote Allen-Bradley PLC 5 family processor (located at minimum 5-miles from the
neargradient Groundwater Remediation System control panel). The communication
network for the communication of this data will include Allen-Bradley data highway
plus communications, data highway plus conversion to RS232 communications, data
transmission via dedicated telephone company wires (modem communications) and at
the remote site conversion back to the Allen-Bradley data highway plus communications.

The programming of the Allen-Bradley PLC 5/25 will be via an Allen-Bradley 1785-T45 lap top computer with Allen-Bradley PCL-5 family programming software (6200 series).

The programming of the Allen-Bradley panel view (MMI) will also be via the Allen-Bradley 1785-T45 lap top computer with the Allen-Bradley "panel builder" development software package (and via RS232 communications).

B. Contractor Services Supply Scope

The contractor services supply scope for the PLC processor programming and MMI programming will consist of at minimum the following:

1. General PCL 5/25 ladder logic programming to provide the control functions indicated on the P&ID drawings, I/O schematics, and functional descriptions contained in design document.

2. PLC 5/25 ladder logic programming to provide the control functions for the third party supplied deep bed filter equipment (described generally in the design document and to be implemented from the functional logic diagrams to be provided by the third party equipment vendor).

3. PLC 5/25 ladder logic programming to provide the alarm functions indicated by the P&ID diagrams, I/O schematics (motor O.L. trip status), and the functional description contained in the design document.

4. PLC 5/25 data highway plus peer-to-peer communication programming to provide for the transmission of the general process alarms and PLC system status/fault information data to the PLC5 family processor located in the neargradient treatment building.

5. PLC 5/25 programming to provide the required interface communication functions with the Allen-Bradley panelview MMI.
6. PLC 5/25 programming to provide the 3-mode PID controller functions as indicated on the P&ID drawings and described in the design document (FIC-1, LIC-4 [BIAS to FIC-1 output]), and FIC-2).

7. Any additional PLC 5/25 programming required to obtain the control functionality for a complete operating system as described in the design document and indicated or implied by the contract drawings.

8. Man-machine interface (Allen-Bradley panel view) software configuration (programming) using the Allen-Bradley "panel builder" application software package. The man-machine interface is to include at minimum the following functionality:

   a. Main menu screens(s) - Listing of the system display screens and associated softfunction key for display access.

   b. System summary display(s) - A tabular listing of equipment/motor status along with general bar indications of process measurement values.

   c. Process graphic screen - Two graphic display screens (at minimum) to be based upon the process flow lines and equipment shown on the P&ID drawings 0224-5D2 through 0224-5D8. Process measurement values to be indicated in a numeric readout point located near the applicable process vessel or process line and the process equipment motor status to be indicated by the following color scheme:

      Green - motor running
      Red - motor stopped
      Red (blinking) - motor stopped/fault

      An indication of the local selector switch selected mode will be given by a tag message at each pump or blower motor on the display:

      Auto - pump selected switch set to auto
      Sel - pump selected to run in auto
      Off - pump selected switch set to "off"
An indication of valve status is to be provided by the following color scheme:

- Green - valve open
- Red - valve closed

d. Faceplate displays - The following two types of faceplate displays will be provided at minimum:

1. Three-mode PID controller function faceplate display to include: bar type indication and numeric indication of the process measurement, controller setpoint, and controller output. The controller mode status (auto/manual or standby fault) will also be indicated. Also, a means of operator initiated controller mode changes, set point changes, manual controller output manipulation will be provided by this type of face plate display. Process alarms will also be indicated by this type of display. This type of faceplate display to be configured for FIC-1, LIC-1, and FIC-2.

2. Process variable (indication only) faceplate display: bar type indication of the process measurement value and a numeric indication of the same value. Also process alarm indication will be provided by this type of display. This type of display to be configured for LI-1 and LI-2.

e. Alarm summary screens - An alarm summary screen will be provided to list the alarm tag name/message of the alarm and the date/time of the alarm occurrence. Also an indication of the alarm condition return to normal is to be provided. Software configuration will be provided to print each alarm as it occurs on the alarm printer. The alarm summary is to also include PLC system alarms: processor fault, communication errors, low PLC processor battery, and any other critical system alarms. The acknowledgement function to be available via softfunction key only from this display.

f. Softfunction keys - A portion of each display screen shall be allocated for the indication of the softfunction keys assigned to a particular screen. Each screen will include at the minimum the following softfunction key assignments:

- Main menu - F1
- Previous display - F2
Next display - F3
Alarm summary screen - F4

g. Display screens alarm indication - A portion of each display screen will be allocated for alarm indication (indication that an alarm condition exists). This area to be the same area on each display (preferably the top left area of each display screen).

C. Contractor Provisions/Requirements - The contractor is to supply any additional required programming to provide the functionality called for by this document, the design document, or indicated or implied by the system design drawings/documents. The contractor is to provide a complete and operational system.

The contractor provided programming personnel are to be familiar with the PLC-5 and panelview instruction sets and the personnel involved with programming implementation will be required for field start-up and debugging services (unless approval is given otherwise).

The contractor will make provisions for system staging of the PLC-5/25 and MMI. This staging will allow for elimination of the majority of the system programming bugs prior to field start-up and checkout.

The contractor is to purchase at the minimum an Allen-Bradley 17785-T45 (IBM-PC compatible laptop computer) and the required PLC-5 family programming application programming software package (6200 series software), the “panel builder” software package, any required communication circuit boards, and any required communications interconnecting cables required for the programming functions.

This programming equipment and software will be included as part of the contractor supplied equipment for the project. This programming equipment will be used at project completion by the plant maintenance personnel for troubleshooting and any required future modifications to the software programming/configuration.
The contractor is required to provide a complete and operating control system including, but not limited to:

- PLC and MMI equipment
- Instrumentation and control system hardware and control panels
- Software programming services
- Purchase of required programming requirement and software
- Field installation and wiring interconnection of all control devices and equipment
- Start-up and checkout of control system
- Calibration of instrumentation devices

END OF SECTION
DIVISION 15

Mechanical
SECTION 15061
STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to provide all steel pipe and appurtenances as shown on the Drawings and as specified herein.

B. Steel pipe shall include black steel and galvanized steel pipe and fittings.

1.02 RELATED WORK NOT INCLUDED

A. Concrete work is specified under Division 3.

B. Painting, except as specified herein, is included in Division 9.

C. Valves and appurtenances are included in Section 15100.

1.03 DESCRIPTION OF SYSTEM

A. Steel piping shall be installed in the locations shown on the Drawings.

B. The equipment and materials specified herein are intended to be standard types of steel pipe and fittings for use in transporting air and fluids.

1.04 QUALIFICATIONS

A. All steel pipe and fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.

B. Steel pipe and fittings shall conform to all applicable standards of ASTM, ANSI, and AWWA.
PART 2 PRODUCTS

2.01 MATERIALS

A. Seamless steel pipe shall be standard weight, of thickness as shown in the schedule at the end of this Section and shall conform to ASTM Designation A120.

B. Joints for pipe 1-1/2 inches or less in diameter shall be threaded for standard screwed joints.

C. Fittings for steel pipe 1-1/2 inches or less in diameter shall be standard malleable iron, 150 pounds. Fittings shall conform to ASTM Designation A47, Grade 32510 service rating. For galvanized pipe, fittings shall also be hot-dipped galvanized and shall conform to ASTM Designation A153. Joints for fittings shall be threaded for standard screwed joints.

D. Where flanged connections are indicated or otherwise required on pipe 1-1/2 inches or less in diameter for connection to flanged valves, fittings, and appurtenances, they shall be made up using companion-type flanges. Where flanged fittings are indicated or otherwise required, they shall be made up using threaded steel nipples and steel companion-type flanges. Companion flanges shall be steel, flat-face flanges of the threaded type. Flanges shall be spot-faced on the back around each bolt hole.

E. Pipe greater than 1-1/2 inches in diameter shall have threaded or welded joints. Threaded joints, fittings, and flanges shall be as specified above for steel pipe 1-1/2 inches or less in diameter. Welded joint pipe shall have beveled ends for welding. Fittings shall be steel, butt-weld type, standard wall, conforming to ANSI B16.9 and ASTM A234, Grade WPB. Flanges shall be steel slip-on or welding-neck type, raised-face, class as shown in the schedule at the end of this Section, conforming to ASTM A105 and ANSI B16.5. Flanges for pipe greater than 1-1/2 inches shall be provided where shown on the Drawings. Gaskets shall be ring-type, full face, non-asbestos, 1/16-inch thick. Bolts and nuts for flanges shall be hex-head cap screws conforming to ANSI B16.2, coarse threads, Class 2A fit, manufactured of ASTM A307, Grade B steel. Split- or grooved-type couplings shall be used where shown on the Drawings and may be used in lieu of flanged or welded joints as approved by the Government Contracting Officer. Pipe for grooved couplings shall have grooved ends for a rigid joints, unless flexible joint is shown on the Drawings.
PART 3  EXECUTION

3.01 INSTALLATION

A. Steel pipe shall be installed true to alignment, and rigidly supported. Anchors shall be provided as shown on the Drawings. After installation, the piping shall be tested as specified in paragraph 3.02, below.

B. All threads shall be clean, machine cut, and all pipe shall be reamed before erection. Each length of pipe as erected shall be up-ended and rapped to dislodge dirt and scale.

C. Screwed joints shall be made up with good quality thread compound and applied to the male thread only. After having been set up, a joint must not be backed off unless the joint is completely broken, the threads cleaned, and new compound applied. All joints shall be air tight.

D. Compressed air piping shall be sloped 1/16 inch per foot and provided with drip legs at low points.

E. All piping shall have a sufficient number of unions to allow convenient removal of piping. Unions shall be compatible with pipe.

F. When cutting of pipe is required, the cutting shall be done by machine in a neat workmanlike manner without damage to the pipe. Cut ends shall be smooth and at right angle to the axis of the pipe.

G. All field welding shall be in accordance with the American Welding Society Standards. The strength of the field weld shall develop the strength of the pipe.

3.02 TESTING

A. All pipe lines shall be tested for compliance with the Specifications. If leaks are discovered, they shall be repaired and the repair approved by the Government Site Representative. Pressure and leakage tests will be required. The test pressures for the various pipe lines shall be as listed below:
B. After installation, all piping shall be flushed clean and then tested at least 1 hour at the test pressure specified. If any joint or pipe section proves to be defective, it shall be repaired and the pipe retested.

### 3.03 SURFACE PREPARATION AND PAINTING

A. All piping and fittings exposed to view shall have its surface prepared and be field painted as specified in Section 09902. Surface preparation and shop priming is a part of the work of this Section. Pipe finish painting and marking is included in Division 9.

END OF SECTION
SECTION 15064
PLASTIC PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required and install plastic piping and appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK NOT INCLUDED

A. Concrete work is specified under Division 3.
B. Field painting is included in Division 9.
C. Valves and appurtenances are included under Section 15100.

1.03 DESCRIPTION OF SYSTEM

A. Piping shall be installed in those locations as shown on the Drawings.
B. The equipment and materials specified herein are intended to be standard types of plastic pipe and fittings for use in transporting water, air and chemicals.

1.04 SUBMITTALS

A. Shop drawings including piping layouts and schedules shall be submitted to the Government Contracting Officer in accordance with Section 01300 and shall include dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports, and all other pertinent technical specifications for all piping to be furnished.

B. Shop drawing submittals for piping under this section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layouts for each piping submittal.
1.05 QUALIFICATIONS

A. All plastic pipe and fittings shall be furnished by a single manufacturer who is experienced in the manufacture of the items to be furnished. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall be suitable for the intended service.

PART 2 PRODUCTS

2.01 MATERIALS

A. Plastic pipe shall be manufactured from rigid, unplasticized polyvinylchloride meeting ASTM D1784, Class 12454-B. The pipe shall be manufactured in accordance with ASTM D1785, PVC 1120. The pipe shall have a hydrostatic design stress rating of 2,000 psi at 73 degree F and shall be suitable for field cutting and solvent welding. Pipe shall be of the sizes as shown on the Drawings and of the thickness as shown in the schedule at the end of this section.

B. Plastic fittings shall be the socket type for solvent-welded joints conforming to ASTM D2467 and D2466, for PVC. Solvent shall be as specified in ASTM D2564 extend where threaded or flanged connections are shown on the Drawings. Joints shall be flanged where shown on the Drawings. Flanges shall be furnished with 1/8-inch thick full-faced natural rubber gaskets which shall be of a material suitably resistant to the fluid within the respective pipelines, and shall be subject to the approval of the Government Contracting Officer.

C. Fittings, specials, unions and flanges shall be of the same schedule number and manufactured of the same materials as the pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. The installation of plastic pipe shall be strictly in accordance with the manufacturer's technical data and printed instructions.
B. Joints for plastic pipe shall be solvent-welded except flanged or threaded where required. In making solvent-welded connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth, if necessary, and apply solvent cement of the proper grade. Solvent-welded joints shall be made in accordance with ASTM D-2855.

C. Installation of valves and fittings shall be strictly in accordance with manufacturer's instructions. Particular care shall be taken not to overstress threaded connections. In making solvent-weld connections, the solvent shall not be spilled on valves or allowed to run from joints.

D. All piping shall have a sufficient number of unions to allow convenient removal of piping and shall be as approved by the Government Project Manager.

E. Where plastic pipe passes through wall sleeves, the space between the pipe and sleeve shall be sealed with a mechanical sealing element.

F. All pastic pipe to metal pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves or couplings, nor shall plastic piping be threaded into metal valves, fittings or couplings. Only socket-to-thread adaptors shall be used for threaded connections.

G. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout, and the Contractor shall verify these locations from approved piping layout drawings and the structural drawings.

3.02 INSPECTION AND TESTING

A. All pipelines shall remain undisturbed for 24 hours to develop complete strength at all joints. All pipelines shall be flushed clean and then subjected to a hydrostatic pressure test for 12 hours at a test pressure specified in the schedule at the end of this section. All leaks shall be repaired and lines retested as approved by the Government Site Representative. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during tests.
A. All piping and fittings exposed to view shall have their surfaces prepared and be shop-painted as specified in Section 09901. Surface preparation and shop priming are a part of the work of this section. Pipe finish painting and marking are included in Section 09902 but shall be part of the work of this section to assist as required by the Government Project Manager in identifying pipe contents, direction of flow, and all else required for proper finish-painting and marking of pipe.

PLASTIC PIPE SCHEDULE

<table>
<thead>
<tr>
<th>Piping System</th>
<th>Pipe Diameter (Inches)</th>
<th>Pipe Schedule</th>
<th>Test Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>75% Phosphoric Acid Feed</td>
<td>1/2</td>
<td>80</td>
<td>150</td>
</tr>
<tr>
<td>29% Ammonia Feed</td>
<td>1/2</td>
<td>80</td>
<td>150</td>
</tr>
<tr>
<td>Biosubstrate Feed</td>
<td>1/2</td>
<td>80</td>
<td>150</td>
</tr>
<tr>
<td>Effluent Pipeline</td>
<td>20</td>
<td>40</td>
<td>100</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1  GENERAL

1.01  SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidental required to provide all Fiber Reinforced Plastic (FRP) pipe and appurtenances as shown on the Drawings and as specified herein.

1.02  RELATED WORK NOT INCLUDED

A. Concrete work is specified under Division 3.
B. Painting, except as specified herein, is included in Division 9.
C. Valves and appurtenances are included in Section 15100.

1.03  DESCRIPTION OF SYSTEM

A. FRP piping shall be installed in the locations shown on the Drawings.

B. The equipment and materials specified herein are intended to be standard types of FRP pipe and fittings for use in transporting fluids.

1.04  QUALIFICATIONS

A. All FRP pipe and fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.

B. FRP pipe and fittings shall conform to all applicable standards of ASTM, ANSI, and AWWA.
PART 2  PRODUCTS

2.01  MATERIALS

A. FRP pipe shall conform to ASTM D2996. The inner surface of the pipe shell have a smooth uniform continuous, resin-rich, surface liner conforming to ASTM D 2996. Seamless steel pipe shall be standard weight, of thickness as shown in the schedule at the end of this Section and shall conform to ASTM Designation A120.

B. Joints shall be ball and spigot with elastomeric gasket, threaded and bonded coupling, or tapered ball and spigot with compatible adhesive.

C. Fittings shall be compatible with the pipe supplied.

PART 3  EXECUTION

3.01  INSTALLATION

A. FRP pipe shall be installed in accordance with ASTM D 3839. Anchors shall be provided as shown on the Drawings.

B. Assembly of the pipe shall be done in strict conformance with the manufacturer's written instruction and installation procedures. Field joints shall be prepared as specified by the pipe manufacturer. Several pipe joints having interference-fit type couplings may be field bonded and cured simultaneously. However, the pipe shall not be moved nor shall additional joints be made until the previously laid joints are completely cured. Joints not having interference-fit type coupling shall be fitted with a clamp which shall hold the joint rigidly in place until the joint cement has completely cured. The clamps shall have a protective material on the inner surface to prevent damage to the plastic pipe when the clamp is tightened in place. The pipe manufacturer shall provide a device or method to determine when the joint is pulled against the pipe stop. Additionally, the pipe manufacturer shall furnish a gauge to measure the diameter of the spigot ends to ensure the diameter conforms to the tolerances specified by the manufacturer. All pipe ends shall be gauged. Factory certified tests shall have been satisfactorily performed to verify that short-term rupture strength is 1,500 psi or greater when carried out in accordance with ASTM D 1599. All field bonded epoxy-cemented joints, regardless of ambient temperature, shall be cured
with a self-regulating thermostatically temperature controlled electrical heating blanket for the time and temperature recommended by the manufacturer for the applicable size and type of joint, or by an alternate heating method recommended by the manufacturer and approved by the Government Contracting Officer. The joint sections shall not be moved during heating or until the joint has cooled to ambient temperature.

C. Metal to FRP pipe connections shall be made by bolting steel flanges to FRP pipe flanges. Cast-iron fitting with gasket bell or mechanical joint may be used with RTRP if pipe has cast iron outside diameter. Steel flanges shall be flat faced type. Where raised face steel flanges are used, spacer rings must be utilized to provide a flat face seat for pipe flanges. A full face Buna "N" gasket 1/8-inch thick with a shore hardness of 50-60 shall be used between all flanged connections. The FRP pipe flange shall have raised sealing rings. Flat washers shall be used under all nuts and bolts on pipe flanges.

3.02 TESTING

A. All pipe lines shall be tested for compliance with the Specifications. If leaks are discovered, they shall be repaired and the repair approved by the Government Site Representative. Pressure and leakage tests will be required.

B. After installation, all piping shall be flushed clean and then tested at least 1 hour at the test pressure specified. If any joint or pipe section proves to be defective, it shall be repaired and the pipe retested.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to provide all ductile iron piping, gray iron or ductile iron fittings, and appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK NOT INCLUDED

A. Concrete work is included in Division 3.
B. Painting, except as specified herein, is included in Division 9.
C. Valves and appurtenances are included in Section 15100.
D. Trenching, backfilling, and compacting are included in Section 02221.

1.03 DESCRIPTION OF SYSTEMS

A. Piping shall be installed in those locations as shown on the Drawings.
B. The equipment and materials specified herein are intended to be standard types of ductile iron pipe, gray iron or ductile iron fittings and appurtenances.
C. Unless otherwise shown on the Drawings or specified herein, all buried ductile iron piping shall be mechanical joint and all nonburied ductile iron piping shall be flanged.

1.04 QUALITY ASSURANCE

A. All ductile iron pipe and fittings shall be from a single manufacturer. All ductile iron pipe to be installed under this contract shall be inspected at the foundry for compliance with the standards specified herein.
B. Inspection of the pipe may also be made by the Government Site Representative after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.05 REFERENCE STANDARDS

A. **ASTM A307.** Carbon steel, externally threaded standard fasteners.

B. **ASTM D1330.** Rubber sheet gaskets.

C. **ANSI A21.4/AWWA C104.** Cement mortar lining for cast iron and ductile iron pipe and fittings for water.

D. **ANSI A21.51/AWWA C151.** Ductile iron pipe, centrifugally cast in metal molds or sand-lined molds, for water or other liquids.

E. **AWWA C606.** Grooved and shouldered type joints.

F. **ANSI A21.10/AWWA C110.** Gray iron and ductile iron fittings 3 inches through 48 inches for water and other liquids.

G. **ANSI A21.15/AWWA C115.** Flanged cast iron and ductile iron pipe with threaded flanges.

H. **ANSI A21.11/AWWA C111.** Rubber gasket joints for cast iron and ductile iron pressure pipe and fittings.

I. **ANSI B2.1.** Pipe threads.

J. **ANSI B16.1.** Cast iron pipe flanges and flanged fittings, Class 25, 125, 250, and 800.
PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe

1. Flanged ductile iron pipe shall conform to the physical and chemical requirements of ANSI A21.51/AWWA C151, and shall have dimensions and wall thicknesses and flanges in accordance with ANSI A21.15/AWWA C115, thickness Class 53, rated working pressure of 125 psi.

2. Mechanical joint ductile iron pipe shall be Class 50. Joints shall conform to ANSI A21.11/AWWA C111, as applicable.

3. Pipe for use with split couplings shall be ductile iron and shall have radius grooved ends conforming to AWWA C606. Pipe wall thickness for grooved pipe shall be Class 53.

B. Fittings

1. Fittings shall be ductile iron or gray iron as specified above. Fittings shall conform to ANSI A21.10/AWWA C110 for 150 psi minimum pressure rating.

C. Joints

1. Flanged joints shall be 125-pound threaded flanges conforming to ANSI B16.1 for pipe and ANSI 21.10 for fittings. The pipe flanges shall be flat faced. Flanges shall be faced and drilled after being screwed on the pipe, with flanges true to 90 degrees with the pipe axis and shall be flush with end of pipe.

2. Gaskets shall be full hypalon or neoprene with cloth insertion, 1/8-inch thick and shall conform to the dimensions shown in Table A.1 of ANSI A21.15/AWWA C115.

3. Flanged joints shall be supplied with bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. Bolts and nuts shall, except as otherwise specified or noted on the Drawings, conform to the ASTM A307, Grade B.

D. Pipe Coating

1. All pipe and fittings shall have a cement mortar lining and bituminous seal coat on the inside in accordance with ANSI A21.4/AWWA C104, except that cement mortar lining shall be 1/8-inch in thickness for pipe 2 inches to 12 inches in diameter.

2. All buried pipe and fittings shall have an exterior bituminous coating in accordance with ANSI A21.51/AWWA C151.

3. Pipe and fittings exposed to view in the finished work shall not receive the standard asphalt coating but shall be shop primed on the outside in accordance with Section 09901. All other pipe and fittings shall be shop coated on the outside with bituminous coating in accordance with the above referenced Specifications and will not require any other coating. If it is necessary to use bituminous coated pipe in exposed areas, the coating shall be completely removed by blast cleaning and the cleaned surfaces shall be immediately primed as specified in Section 09901.

PART 3  EXECUTION

3.01  HANDLING PIPE AND FITTINGS

A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before installing, and no piece shall be installed which is found to be defective. All damage to the pipe linings or coatings shall be repaired.

B. All pipe and fittings shall be subjected to a careful inspection and hammer test just prior to being installed.

C. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner. All pipe and fittings shall be
thoroughly cleaned before installing, shall be kept clean until they are used in the work, and, when installed, shall conform to the lines, grades, and dimensions required.

3.02 SURFACE PREPARATION AND PAINTING

A. All piping and fittings exposed to view shall have its surface prepared and be shop painted as specified in Section 09901. Surface preparation and shop priming is a part of the work of this Section. Pipe finish painting and marking is included in Section 09902, but is shall be part of the work of this Section to assist as required by the Government Contracting Officer in identifying pipe contents, direction of flow, and all else required for proper finish painting and marking of pipe.

3.03 INSTALLATION

A. All piping and fittings shall be installed true to alignment and rigidly supported thrust anchors shall be provided where required. Any damage to linings or coatings shall be repaired before the pipe is installed. Each length of pipe shall be cleaned out before erection.

B. Sleeves shall be installed of proper size for all pipes passing through floors or walls as shown on the Drawings. Where indicated on the Drawings, or required for liquid or gas tightness, the pipe shall be sealed.

C. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and jointing method and their locations shall be verified from approved piping layout drawings and the structural drawings.

D. Except as otherwise shown on the Drawings, either split-type couplings or flange joints may be used at exposed pipe locations. At the Contractor's option, split-type couplings may be used in place of flanged joints, using rigid grooving. Split-type couplings located as shown on the Drawings with flexible grooving shall be used regardless of whether adjacent joints use flanges or split-type couplings. Prior to approval of joint method, layouts for hanger and supports shall be submitted to the Government Project Manager for approval. Pipe for use with non-restrained, sleeve-type couplings shall have plain ends.
E. Flanged joints shall be made with opposite bolts tightened alternately and evenly.

F. All valves, fittings, equipment, and appurtenances needed on the pipelines shall be set and jointed as indicated on the Drawings or as required. All pipe and appurtenances connected to equipment shall be supported in such manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, a certification shall be submitted stating that such requirements have been complied with.

G. All buried pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when laid, shall conform to the lines and grades required. Buried ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA Standard Specification C600, except as otherwise provided herein. Trench backfilling shall be performed in accordance with Section 02221. Blocking will not be permitted. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor.

H. When laying of pipe is not in progress, the open ends of the pipe shall be closed by watertight plugs or other approved means. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by manufacturer. Fittings, in addition to those shown on the Drawings, shall be provided, if required, for crossing utilities which may be encountered upon opening the trench. Solid sleeves shall be used only where approved by the NUS Site Representative.

I. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be jointed with a bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.

J. Mechanical joints shall be made in accordance with Appendix A of ANSI/AWWA C111 and the manufacturer’s instructions. Thoroughly clean and lubricate the joint surfaces and rubber gasket with soapy water before assembly. Bolts shall be tightened to the specified torques. Under no conditions shall extension wrenches or pipe-over-handle of ordinary ratchet wrench be used to secure greater leverage.
3.04 TESTING

A. Piping shall be pressure and leakage tested to 100 psi for compliance with the specifications. If leaks are discovered, they shall be repaired and the piping retested.

B. After installation, all interior ductile iron piping shall be flushed clean and then tested at least 1 hour at the specified test pressure. If any joint or pipe section proves to be defective, it shall be repaired and retested.

C. Make any taps and furnish all necessary caps, plugs, etc., as required in conjunction with testing a portion of the pipe between valves. Furnish a test pump, gauges, and any other equipment required in conjunction with carrying out the hydrostatic tests.

D. The leakage test shall be conducted at the maximum operating pressure as determined by the Government Project Manager, and this pressure shall be maintained for at least 2 hours during the test. The amount of leakage which will be permitted shall be in accordance with AWWA C600.

3.05 CLEANING

A. At the conclusion of the work thoroughly clean all of the new pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required, and install, complete and ready for operation, all valves and appurtenances as shown on the Drawings and as specified herein.

B. The equipment shall include, but not be limited to, the following:

1. Plug valves
2. Butterfly valves
3. Check valves
4. Small-diameter metallic valves
5. Miscellaneous appurtenances

1.02 RELATED WORK NOT INCLUDED

A. Piping is included in other Sections of Division 15.
B. Pneumatically operated deep bed filter control valves are included in Section 11340.
C. Painting is included in Division 9.

1.03 QUALITY ASSURANCE

A. All valves and appurtenances shall be products of well established firms who are fully experienced, reputable and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed and constructed in accordance with the best practices and methods and shall be in compliance with these specifications as applicable.
B. Shop Testing

1. Swing-check valves shall be tested in accordance with requirements of AWWA C508. Shell test shall be at twice the valve-rated working pressure.

2. Gate valves shall be tested in accordance with requirements of AWWA C500. Hydrostatic test at twice the rated working pressure shall be held for a period of 5 minutes.

3. Butterfly valves shall be tested in accordance with requirements of AWWA C504. The tests shall be performance, leakage and hydrostatic, as specified therein.

4. All other valves shall be tested for leakage at the rated pressure and hydrostatically tested at twice the rated pressure. Plug valves shall allow no leakage for a period of at least one-half hour with pressure applied in either direction.

5. Manufacturers shall submit certificates that all valves have been tested and meet specified requirements.

1.04 SUBMITTALS

A. Copies of all materials required to establish compliance with these Specifications shall be submitted in accordance with the provisions of Section 01300. Submittals shall include at least the following:

1. Certified drawings showing all important details of construction and dimensions.
2. Descriptive literature, bulletins, and/or catalogs of the equipment.
3. All requirements of Section 01170.
4. The total weight of each item.
5. A complete total bill of materials.
6. A list of the manufacturer's recommended spare parts.

1.05 OPERATING INSTRUCTIONS

A. Operating and maintenance instructions shall be furnished to the Government Contracting Officer as provided in Section 01170. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment
lists, descriptions, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.06 TOOLS

A. Special tools, if required for normal operation and maintenance, shall be supplied with the equipment in accordance with Section 01170.

PART 2 PRODUCTS

2.01 GENERAL

A. All valves and appurtenance shall have the name of the manufacturer, flow directional arrows, and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

B. All valves shall open counter clockwise unless otherwise specified.

2.02 PLUG VALVES

A. Plug valves shall be of the offset disc type, 1/4 turn, non-lubricated, serviceable under full line pressure and capable of sealing in both directions at the rated pressure. The disc shall be completely out of the flow path when open. Valves 4 inches to 6 inches shall have a minimum port area of 80 percent when measured by the percent cross-sectional area of equivalent size Schedule 40 steel pipe.

B. Except as otherwise noted, valves shall have cast iron construction, rated for 175 psi.

C. Valve bodies shall be cast-iron or stainless steel, as shown above, and of the top entry, bolted-bonnet design, cast with integral flanges conforming to ANSI B16.1 Class 125. All exposed bolts, nuts, and washers shall be zinc- or cadmium-plated, except for buried or submerged valves, which shall have Type 304 stainless-steel hardware.

D. The plug shall be removable without removing the valve from the line and shall have an integral upper and lower shaft with seals on the upper and lower journals to prevent entrance as solids into the journals. Shaft bearings, if provided, shall be
stainless steel at both upper and lower stem journals. The operator shaft shall have
easily replaceable seals which shall not require adjustment.

E. The valve seating surface shall provide full 360-degree seating by contact of a resilient
seating material, compatible with the process stream, on the plug, mating with
welded-in high nickel content overlay surface in the body. The seating design shall be
resilient and of the continuous interface type, having consistent opening and closing
torques, and shall be non-jamming in the closed position.

F. All valves of 6-inch diameter and larger shall be equipped with geared or traveling nut
type operators. All operators shall have enclosed and sealed housings to allow the
reduction mechanism to operate in a lubricant. Seals shall be provided on all shafts to
operate in a lubricant. Seals shall be provided on all shafts to prevent the entry of dirt
and water into the housing. All shaft bearings shall be furnished with permanently
lubricated bronze bearing bushings. Actuator shall clearly indicated valve position,
and an adjustable stop shall be provided. Construction of actuator housing shall be
semi-steel. Hardware on actuators shall be of the same materials as the valves.

G. Operators shall be handwheel, or chain, as noted herein. Handwheel or chainwheel
shall not exceed twice the diameter of the gear.

H. Valves of 4-inch diameter and smaller shall be provided with individual latch lock
levers. Provide adjustable limit stops for both opening and closing, and a clearly
marked position indicator.

I. All valves to be fully tested by the manufacturer prior to shipment.

2.03 BUTTERFLY VALVES

A. Butterfly valves shall conform to AWWA C504, except as specified herein.

B. Exposed valves shall be flanged, short body type in accordance with requirements of
AWWA C504. Buried valves shall be provided with mechanical joint ends.

C. The valve body shall be constructed of close grain cast iron per ASTM A126, Class B,
with integrally cast hubs for shaft bearing housings of the through boss-type, and
without any steps. Provide permanently self-lubricating body bushings, sized to
withstand bearing loads. Stuffing box of liberal dimensions shall be provided on exposed valves at the operator end of the shaft, arranged so that the packing can be replaced by removing the bronze follower without removing the operator. Packing shall be of the Chevron type. A sealing element utilizing O-rings shall also be acceptable on buried valves.

D. The valve shaft shall be on Type 304 stainless steel and designed for both torsional and shearing stresses when the valve is operated under its greatest dynamic, seating, or unseating torque.

E. Valve sides shall conform to the requirement of AWWA C504, except as noted herein. Air service valves shall have stainless steel discs with the periphery machined to a smooth spherical surface. Water service valves shall have cast iron or ductile iron discs.

F. Body-mounted valve seats shall be of the resilient type and shall be buna-N for water service and EPT for air service. Disc edge shall be stainless steel or Ni-chrome.

G. Disc-mounted seats shall be held in place by one-piece, Type 304 stainless steel retaining rings and stainless Nylock screws. Mating seats for water service valves shall be Type 304 stainless-steel or Monel.

H. Valve operators shall be totally enclosed gear operators conforming to requirements of AWWA C504. Operators shall be designed to seat, unseat and hold valve disc in any position without any fluttering or creep. Valves shall be handwheel, chain, or pneumatic operated as specified herein and as shown on the Drawings. Pneumatic operators shall be provided with manual overrides.

Pneumatic operators shall conform to the requirements specified under Section 11340.

2.04 CHECK VALVES

A. Swing Check Valves

1. Swing check valves of 2-inch diameter and larger shall be carbon or steel meeting the requirements of AWWA C508, in as far as applicable.
2. Valves shall have ANSI B16.1 flanges, double disc, Buna N seat, cadmium plated steel intervals, and stainless steel spring.

2.05 SMALL DIAMETER METALLIC VALVES

A. Ball Valves

1. Ball Valves for air service shall be carbon steel, with teflon seats and seal. Valves shall be suitable for operating at pressure up to 100 psig and temperatures of 100°F. Valves shall have threaded ends.

B. Gate Valves

1. Gate valves of 2-1/2-inch diameter and smaller shall be bronze, solid wedge, rising stem type.

C. Solenoid Valves

1. Solenoid valves shall be backless piston type, direct acting, 2-way or 3-way as shown on the Drawings.

2. Solenoid valves shall be of the normally closed type.

3. Valves shall have forged brass bodies, NPT end connections of the size shown on the Drawings, 300 or 400 series stainless steel internal parts, and Buna-N or Ethylene Propylene valve seats. Valves shall have a 150 psig minimum safe working pressure and zero minimum operating pressure differential.

4. Valves shall have NEMA-4 solenoid enclosures, shall be suitable for operation on a 120 volt, 60 ounce, single-phase power supply, and shall be provided with a continuous duty Class F coil and a manual operator.
2.06 MISCELLANEOUS APPURTENANCES

A. Chain Operators

1. Manually operated valves of 4-inch diameter and larger shall be provided with chain wheel operators when the valve is located more than 6 feet above the operating floor.

2. Wheels shall have chain guides to prevent chains from slipping off the wheels. Length of chain shall be selected to place bottom of chain 5 feet above the operating floor.

2.07 SHOP PAINTING

A. Interior ferrous surfaces of all valves, except for stainless steel and bearing surfaces, and the exterior surfaces of buried valves shall be given a shop finish of an asphalt varnish conforming to Federal Specification TT-V51 for Varnish Asphalt.

B. The exterior surface of valves, operators, floorstands, and miscellaneous piping shall be thoroughly cleaned of all scale, dirt, grease, or other foreign matter and coated with one shop coat of an approved rust inhibitive primer such as Inertol Primer No. 621.

C. Ferrous surfaces not to be painted shall be given a shop coat of grease or other suitable rust resistant coating.

PART 3 EXECUTION

3.01 INSTALLATION

A. All valves and appurtenances shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the valves shall be repaired before they are installed.

B. Install all brackets, extension rods, guides, the various types of operators and appurtenances, as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, check all plans and figures which
have a direct bearing on valve location. Contractor shall be responsible for the proper location of valves and appurtenances.

C. Buried flanged or mechanical joints shall be made with Type 316 stainless steel bolts. All exposed bolts and nuts shall be heavily coated with two coats of bituminous paint comparable to Inertol No. 66 Special Heavy.

3.02 FIELD PAINTING

A. Valves shall be field painted as the pipelines in which they are installed. Prepainted items shall be touched up as required after installation.

B. Field painting is specified under Division 9.

3.03 INSPECTION AND TESTING

A. All valves shall be carefully inspected for defects in workmanship and materials; all debris and foreign material cleaned out of valve openings; all operating mechanisms operated to check their proper functioning; and all nuts and bolts checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced.

B. The various pipelines in which the valves and appurtenances are to be installed are specified to be field tested. During these tests any defective valve or appurtenance shall be adjusted, removed and replaced, or otherwise made acceptable to the Government Site Representative.

C. Various regulating valves or other appurtenances shall be tested to demonstrate their conformance with the specified operational capabilities and any deficiencies shall be corrected or the device replaced or otherwise made acceptable to the Government Site Representative.

END OF SECTION
SECTION 15250
THERMAL INSULATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install insulation for exposed parts of air stripping columns (AS-1, AS-2) as shown and scheduled.

B. Furnish and install insulation for Bio-oxidation Towers (BT-1 to BT-3).

C. Furnish and install insulation for Caustic Storage Tank (T-10)

1.02 RELATED WORK NOT INCLUDED

A. Air stripper is included in Section 11375.

B. Bio-oxidation towers are included in Section 11365.

C. Field painting is included in Section 09902.

PART 2 PRODUCTS

2.01 GENERAL

A. The materials supplied shall conform to all governing codes, standards, and specifications. If any departures from the specification are deemed necessary, departures shall not be made without prior written approval of the NUS Project Manager.

B. All materials and integrated insulation assemblies furnished shall have flame spread ratings of not over 25 (fire resistive), smoke developed rating of not over 50, and fuel contributed rating of not over 50, as established by tests conducted in accordance with Interior Federal Standard Number 00136B, entitled "Interior Federal Standard Flame-Spread Properties for Materials" and the National Fire Code of the NFPA. The treatment of jackets or facings to impart flame and smoke safety must be permanent.
(The use of water-soluble treatment is prohibited.) Exception allowed for closed cell foam insulation and PVC fitting covers.

C. The toxicity of the solvents used on the premises must be such that the maximum allowable concentration in parts per million is 200 or according to the latest value published by the American Conference of Governmental Industrial Hygienists and OSHA.

D. Adhesives, coatings, and vapor barrier materials shall be the types with approved compatibility and are recommended for use by the insulation manufacturer. Contractor shall be able to submit a certified statement attesting to its approval. The following adhesives and coatings, as manufactured by Foster Division, H.B. Fuller Company or Childers Products Company, are representative of approved products that meet the above requirements. (Other manufacturers who demonstrate to the satisfaction of the NUS Site Representative that their products are equivalent are acceptable.)

1. Lagging adhesive: 30-40, CP50.
5. Sealing compound adhesive: 30-45, CP70.
6. Weatherproof mastic: 35-01, CP10-1

2.02 INSULATION MATERIALS

A. Insulation Materials shall be as follows.

1. Primer. Futura Elastobond Number 801 butyl rubber by Futura Coatings, Inc., Hazelwood, Missouri or equal.

2. Insulation. Dow Urethane Foam, or equal, 2-pound density, K-value 0.14 new, and 0.19 aged minimum.

3. Finish Coats. Futurathane Number 5007 fast cure aromatic polyurethane elastomer, tensil strength 3,450 psi undercoat material and Futuraflex
Number 550 aliphatic polyurethane topcoat by Futura or equal. Finished color shall be gray as approved.

PART 3 EXECUTION

3.01 GENERAL

A. Do not apply insulation prior to testing and acceptance of equipment. Clean dust, dirt, grease, and moisture from surfaces before applying insulation or insulation adhesives. All insulation shall be installed in a neat and workmanlike manner. Nameplates and equipment certification and data tags affixed to any piece of apparatus must remain exposed to view. Where two layers of insulation are used, stagger all joints both ways. Secure each layer independently. Continue insulation through walls, partitions, floors, and pipe sleeves.

B. The recommendations and instructions of the manufacturers of products used in the work are hereby made part of these specifications except as they may be superseded by other requirements of these specifications.

C. Adhesives, coatings, and vapor barrier materials shall be applied as specified by the manufacturer. Do not apply these materials when ambient temperature is above or below the maximum and minimum ambient temperature, respectively, specified as limits by the manufacturer. In general, these limits are 90°F and 40°F, however, the limitations are to be checked for each product.

D. All penetrations through a vapor barrier for hangers, instruments, etc. shall be sealed to provide a complete vapor barrier. The use of staples or other fasteners that penetrate the vapor barrier is not permitted.

3.02 INSULATION

A. All surface preparation and installation shall conform to manufacturers recommendations and shop drawings as reviewed.

B. Clean the exterior surfaces to remove laitance, coating materials, and all foreign materials and to obtain a proper texture for coating system all as approved.
C. Spray apply system primer to 35 mils dry film thickness (DFT).

D. Spray apply insulation to a 3-inch dry thickness.

E. Spray apply 35 mils DFT undercoat and 15 mils DFT topcoat.

F. Texture of finished system shall be no coarser than an orange peel as approved.

END OF SECTION
DIVISION 16

Electrical
SECTION 16000
ELECTRICAL - GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to make ready for use a complete electrical system at the Heleva Landfill Site, Lehigh County, PA, as hereinafter specified and shown on the Contract Drawings.

B. The work shall include furnishing and installing the following items:

1. Cable Trays, Raceways, Boxes, and Fittings
2. Wires and cables
3. Electric Motors
4. Miscellaneous Equipment (as specified in Section 16191)
5. Underground System
6. Primary Distribution Switchboard
7. 480-volt Motor Control Centers
8. Lighting System
9. Grounding System
10. Fire and Alarm System
11. Security Alarm System
12. Electric Space Heating Equipment

C. Furnish and install overhead secondary service to the switchboard distribution panel.

D. Furnish and install conduit, wire, control equipment and field connections as required for all motors and process equipment furnished under other Divisions of these Specifications.

E. Certain pieces of equipment (e.g., air compressor, filters, etc.) will be furnished unassembled. Complete all work necessary to make this equipment operative.
F. Mount and wire motor control centers, main control panels, deep bed filter panel, switchboard distribution panel, and control devices furnished under other Divisions of these Specifications.

G. Power factor correction capacitors furnished under other Divisions of these Specifications will be mounted and wired by equipment supplier. Where capacitors are furnished with quick-release latched covers, furnish and install a bolt and nut on each latch.

H. Make all field connections to process instrument panels and other control panels furnished under other Divisions of these Specifications.

I. Mount and wire process instruments furnished under other Divisions of these Specifications. Furnish and install all conduit, wire and interconnections between process instrumentation primary elements, transmitters, local indicators, and receivers. Mount and wire all lightning and surge protection equipment at process instrumentation transmitters and receivers.

J. Mount and make field connections to “packaged” equipment furnished under other Divisions of these Specifications.

K. Install and wire all thermostats furnished under other Divisions of these Specifications directly controlling unit heater fan motors.

L. Wire heating, ventilation, and air conditioning equipment furnished under other Divisions of these Specifications.

M. Wire the sump pump and control equipment furnished under other Divisions of these Specifications.

N. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost.
1.02 RELATED WORK NOT INCLUDED

A. Excavation and backfilling, including gravel or sand bedding for underground electrical work is included in Division 2.

B. Concrete work is included in Division 3.

C. Except for directly controlled, 1-phase, unit heater fan motor wiring, temperature, and ventilation control equipment (damper motors, thermostats, duct switches, etc.) and wiring will be furnished under Division 15.

1.03 SUBMITTALS

A. As specified under Section 01300, shop drawings shall be submitted for all materials, equipment, apparatus, and other items as required by the Government Contracting Officer.

B. Shop drawings shall be submitted for the following equipment:

1. 480-volt motor control centers
2. Main control panel
3. HVAC and economizer
4. Heaters-electrical
5. Lighting fixtures
6. Telephone system
7. Fire alarm system
8. Security alarm system
9. Deep bed filter panel
10. Switchboard distribution panel

C. The manufacturers name and product designation or catalog numbers shall be submitted for the following material:

1. Wire
2. Conduit
3. Wiring devices
4. Boxes and fittings
5. Mechanical seals
6. Hangers

D. Prior to submittal, all shop drawings shall be checked for accuracy and contract requirements. Shop drawings shall bear the date checked and shall be accompanied by a statement that the shop drawings have been examined for conformity to Specifications and Drawings. This statement shall also list all discrepancies with the Specifications and Drawings. Shop drawings not so checked and noted shall be returned.

E. The Government Project Manager's check shall be only for conformance with the design concept of the project and compliance with the Specifications and Drawings. The responsibility of, or the necessity of, furnishing materials and workmanship required by the Specifications and Drawings which may not be indicated on the shop drawings is included under the Contractor's scope of work.

F. The responsibility for all documents to be confirmed and at the job site and for coordination of this work with the work of all other trades is also included under the Contractor's scope of work.

G. No material shall be ordered or shop work started until the Government Project Manager's approval of shop drawings has been given.

1.04 SERVICE AND METERING

A. The power company serving this project is the Pennsylvania Power and Light, Allentown, Pennsylvania office.

B. Service will be obtained at 480, 3 phase, 3 wire from transformers furnished and installed by the power company.

C. The Contractor shall furnish and install the entrances conduit, cable and connectors for the utility connections at the building.

D. The power company will install metering current transformers (CTs).
E. The meter base and enclosure shall be provided by the power company. A 1 1/2-inch conduit with a nylon pull line shall be run from the CTs to the meter enclosure. Meter wiring will be furnished, installed, and connected by the power company.

F. Metering shall be located outside of fenced area.

G. Make all arrangements with the power company for obtaining service, pay all power company charges for service, and furnish all labor and material for the service.

1.05 CODES, INSPECTION AND FEES

A. All material and installation shall be in accordance with the 1990 National Electrical Code and the state or the local authority having jurisdiction.

B. Pay all fees required for permits and inspections.

1.07 TESTS AND SETTINGS

A. Test all systems furnished under Division 16 and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Government's personnel in the proper operation of the systems.

1.08 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured. Provide fire stops as necessary.

1.09 CUTTING AND PATCHING

A. All cutting and patching shall be done in a thoroughly workmanlike manner.
1.10 INTERPRETATION OF DRAWINGS

A. The Drawings are not intended to show exact locations of conduit runs.

B. Each three-phase circuit shall be run in a separate conduit unless otherwise shown on the Contract Drawings.

C. Unless otherwise approved by the Government Site Representative conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.

D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation.

E. Verify with the Government Site Representative the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

F. Any work installed contrary to or without approval by the Government Site Representative shall be subject to change as directed by the Government Site Representative, and no extra compensation will be allowed for making these changes.

G. The locations of equipment, fixtures, outlets, and similar devices shown on the Contract Drawings are approximate only. Exact locations shall be as approved by the Government Site Representative during construction. Obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Government Site Representative and furnish all labor and materials necessary to complete the work in an approved manner.

H. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.
I. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of the equipment.

J. All connections to equipment shall be made as required, and in accordance with the approved shop and setting drawings.

1.11 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the structure.

B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

1.12 RECORD DRAWINGS

A. As the work progresses, all field changes or revisions shall be legibly recorded on two (2) sets of project contract drawings. These drawings shall be given to the Government Contracting Officer at the completion of the project.

B. All underground cable shall be recorded, and this information shall be presented to all utilities, local authorities, and property owners.

1.13 COMPONENT INTERCONNECTIONS

A. Components of equipment furnished under this Specification will not be furnished as integrated systems.

B. Analyze all systems components and their shop drawings; identify all terminals and prepare drawings or wiring tables necessary for component interconnection. Furnish
two copies of interconnection wiring diagrams and tables to the Government Contracting Officer.

C. Furnish and install all component interconnections.

1.14 MANUFACTURERS SERVICES

A. Provide manufacturer's services for testing and start-up of the following equipment:

1. Level and flow controls (3 day, 1 trip minimum).
2. Variable freq. drives (2 days, 1 trip minimum).
3. Security alarms (1 day, 1 trip minimum).
4. Fire alarm (1 day, 1 trip minimum).

1.15 MATERIALS

A. The materials used in all systems shall be new, unused and as hereinafter specified. All materials where not specified shall be of the very best of their respective kinds. Samples of materials or manufacturer's specifications shall be submitted for approval as required by the Government Project Manager.

B. Materials and equipment used shall be Underwriters Laboratories, Inc. listed.

C. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. If any apparatus has been damaged, such damage shall be repaired at not additional cost. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such special tests as directed by the Government Site Representative.

1.16 EQUIPMENT IDENTIFICATION

A. All equipment (disconnect switches, separately mounted motor starters control stations etc.) furnished under this Division shall be identified by the name of the process, HVAC, etc. equipment it serves. Motor control centers, control panels, main control panel...
junction or terminal boxes, transfer switches, etc. shall have nameplates where identified by letter or number on the Contract Drawings.

B. The identification method shall be laminated plastic nameplates. Nameplates shall be not less than 1/16-in x 3/4-in x 2-1/2-in with 3/16-in high black letters on a white background.

C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be cemented to all other enclosure types using epoxy or other approved adhesive. Where the equipment size does not have space for mounting a nameplate the nameplate shall be cemented to the adjacent mounting surface. Cemented nameplates shall not be drilled.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install complete raceway systems as shown on the Contract Drawings and specified.

B. Furnish and install all cable tray, fittings, supports, hangers, and miscellaneous hardware as hereinafter specified or as shown on the Contract Drawings.

1.02 RACEWAY APPLICATIONS

A. Except where otherwise shown on the Contract Drawings, or specified, all wiring shall be in rigid steel conduit.

B. Rigid steel conduit shall be used at all locations (underground and within structures) as raceways for shielded process instrumentation wiring and shielded control wiring.

C. PVC coated rigid steel conduit shall be used where shown on the Contract Drawings.

D. All conduit of a given type shall be the product of one manufacturer.

1.03 CABLE TRAY APPLICATIONS

A. Except where otherwise shown on the Contract Drawings, or specified, all cable tray shall be corrosion-resistant metal or with a corrosion resistant finish.

B. Installation shall comply with the latest manufacturer's recommended standards for deflection, static loads, thermal contraction and expansion, and cable installation methods.

C. All installed cable tray shall be of the same manufacturer.
D. Sizes

1. Maximum rung spacing shall be nine (9) inches.

2. Minimum loading depth shall be five (5) inches.

3. Minimum radius on all fittings shall be twenty four (24) inches, unless approved by the Government Site Representative.

E. Markings

1. All tray runs shall have a permanently fixed nameplate with the tray number at intervals of not less than ten (10) feet, or at the transition point of different tray numbers, and be attached to both sides of the installed tray.

2. Tray nameplates shall be readily visible and legible from floor level.

1.04 BOX APPLICATIONS

A. Unless otherwise hereinafter specified or shown on the Contract Drawings, all boxes shall be metal.

B. Exposed switch, outlet and control station boxes and fittings shall be cast or malleable iron.

C. Terminal boxes, junction boxes, pull boxes, etc. shall have NEMA 1A enclosures in clean indoor areas, NEMA 4 enclosure in outdoor area.

1.05 FITTINGS APPLICATIONS

A. Combination expansion-deflection fittings shall be used where conduits cross structure expansion joints. Refer to Structural Contract Drawings for expansion joint locations.

B. Conduit wall seals shall be used where underground conduits penetrate walls or at other locations shown on the Contract Drawings.
PART 2 PRODUCTS

2.01 MATERIALS

A. Rigid Metal Conduit


2. Rigid steel conduit shall be as manufactured by the Allied Tube and Conduit Corp., Triangle PWC Inc., Wheatland Tube Co. or approved equal. The interior and exterior shall be hot-dipped galvanized after threading.

3. PVC coated rigid steel conduit shall have a 0.040-in thick, polyvinyl chloride coating permanently bonded to hot-dipped galvanized steel conduit with epoxy coated interior, as manufactured by Robroy Industries, Triangle PWC inc., Perma-Cote Industries or approved equal.

B. Liquidtight, Flexible Metal Conduit, Couplings and Fittings

1. Liquidtight, flexible metal conduit shall be for use under the provisions of the 1990 N.E.C. Article 351.

2. Liquidtight, flexible metal conduit shall be Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div., Anaconda American Brass Co., American Flexible Conduit Co., Inc., Universal Metal Hose Co. or approved equal.

3. Fittings used with flexible conduit shall be of the screw-in type as manufactured by the Thomas and Betts Co., Crouse-Hinds Co., Appleton Electric Co. or approved equal.

C. Flexible Couplings

1. Flexible couplings shall be as manufactured by the Crouse-Hinds Co., Appleton Electric Co., Killark Electric Manufacturing Co. or approved equal.
D. Boxes and Fittings

1. NEMA Type 1 terminal boxes, junction boxes, and pull boxes shall be sheet steel unless otherwise shown on the Contract Drawings. Boxes shall be galvanized and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall have no holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall be gasketed and fastened with stainless steel screws. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets.

2. NEMA Type 4 terminal boxes, junction boxes and pull boxes shall be stainless steel unless otherwise shown on the Contract Drawings. Boxes shall have continuously welded seams. Welds shall be ground smooth. Boxes shall be flanged and shall have no holes or knockouts. Box bodies shall not be less than 14 gauge with covers not less than 12 gauge metal. Covers shall be gasketed and fastened with stainless steel clamps. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets.

3. All boxes and fittings used with PVC coated conduit shall be furnished with a PVC coating bonded to the metal, the same thickness as used on the coated steel conduit.

4. Cast or malleable iron device boxes shall be Type FD. All cast or malleable iron boxes and fittings shall have cadmium-zinc finish.

5. Steel elbows and couplings shall be hot-dipped galvanized. Elbows and couplings used with PVC coated conduit shall be furnished with a PVC coating bonded to the steel, the same thickness as used on the coated steel conduit.

6. Conduit hubs shall be as manufactured by Myers Electric Products, Inc., Raco Div., Appleton Electric Co. or approved equal.
7. Conduit wall and floor seals for sleeved openings shall be type CSMI as manufactured by the O.Z./Gedney Co., Spring City Electric Co. or approved equal.

8. Combination expansion-deflection fittings shall be Type XD as manufactured by the Crouse-Hinds Co., O.Z./Gedney Co., Spring City Electrical Mfg. Co. or approved equal.

E. Conduit Mounting Equipment

1. Hangers, rods, backplates, beam clamps etc. shall be hot-dipped galvanized iron or steel. They shall be as manufactured by the Appleton Electric Co., Thomas and Betts Co., Unistrut Corp., or approved equal.

2. Hangers, backplates, beam clamps, etc. used with PVC coated rigid steel conduit shall have a PVC coating similar and equal to the conduit. Rods shall be stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION CONDUIT AND FITTING

A. No conduit smaller than 1/2-in electrical trade size shall be used, nor shall any have more than three 90 deg bends in any one run. Pull boxes shall be provided as required or directed.

B. No wire shall be pulled until the conduit system is complete in every detail.

C. The ends of all conduit shall be tightly plugged to exclude dust and moisture while the buildings are under construction.

D. Conduit supports shall be spaced at intervals of 8 ft. or less, as required to obtain rigid construction.

E. Single conduit shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduit from the surface. Multiple runs of conduit shall be supported on trapeze type hangers with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-in. diameter.
F. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete inserts of the spot type shall be provided.

G. All conduit on exposed work shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduit shall be run perfectly straight and true.

H. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings.

I. Conduit terminating in gasketed enclosures shall be terminated with conduit hubs.

J. Conduit shall be installed using threaded fittings. Threadless fittings may be used in isolated instances when approved by the Government Site Representative.

K. Liquidtight flexible metal conduit shall be used for all motor terminations and other equipment where vibration is present.

3.02 MINIMUM SPACING BETWEEN RACEWAYS

A. A minimum spacing of 36 inches shall be maintained between parallel runs of raceways carrying 120 volt 60 Hertz or 480 volt 60 Hertz power wires and raceways containing shielded cables or data highway cables.

B. Where power and signal raceways cross, the crossing shall be at a 90 degree angle and with minimum 18 inch separation. Where 18 inch separation is not practical, obtain permission from the Government Site Representative for reduced clearance, but in all cases a minimum 6 inch clearance shall be maintained.
3.03 INSTALLATION CABLE TRAY

A. Cable tray shall be installed per the Contract Drawings unless otherwise directed and approved by the Government Site Representative.

B. Tray runs must be installed as a complete system prior to cable installation.

C. Tray installation shall comply with article 318 of the 1990 National Electrical Code.

D. A copper grounding conductor shall be bonded to the entire length of the tray per manufacturer's recommendations.

E. Tray shall be connected to the building ground system as directed by the Government Site Representative.

F. Tray components shall comply with the Bill of Materials on the Contract Drawings, and shall be manufactured by B-Line or approved equal.

G. Tray supports shall be spaced as per manufacturer's recommendations and shall be approved by the Government Site Representative prior to installation.

H. All cable entering or leaving the cable trays shall be softened to preclude damage to the cable insulation.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish, install and test all wire, cable and appurtenances as shown on the Contract Drawings and as hereinafter specified.

1.02 SUBMITTALS

A. Samples of proposed wire shall be submitted for approval. Each sample shall have the size, type of insulation and voltage stenciled on the jacket.

B. Approved samples will be sent to the project location for comparison by the Government Site Representative with the wire actually installed.

C. Installed, unapproved wire shall be removed and replaced at no expense to the Government.

1.03 APPLICATIONS (600 V. OR LESS)

A. Wire for lighting, receptacles, and other 120/208 volt circuits shall be NEC type THHN/THWN.

B. Wire for 480 volt circuits shall be NEC type XHHW for sizes 4/0 AWG and smaller, and shall be NEC type RHW for sizes 250 MCM and larger.

C. Wire for control circuits shall be NEC type THHN/THWN, stranded.
D. Cable for 4-20 mA instrumentation circuits, potentiometer circuits and RTD circuits shall be multi-conductor No. 16 AWG twisted and shielded.

E. Equipment grounding conductors installed in raceways shall be NEC type THW, green. Grounding electrode conductors shall be uninsulated.

1.04 MINIMUM SIZES

A. Except for control, signal, and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.

PART 2 PRODUCTS

2.01 MATERIALS

A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.

B. All conductors shall be stranded, except that lighting and receptacle branch circuit wiring may be solid.

2.02 600 VOLT OR LESS WIRE AND CABLE

A. Types THHN/THWN, XHHW, RHW and USE wire shall be as manufactured by the Collyer Insulated Wire Co., Pirelli Cable Corp., or General Cable Co. or approved equal.

B. Instrumentation cable shall be twisted pair, 600 V, polyethylene insulated, aluminum/polyester tape shielded with No. 16 AWG tinned copper drain wire (100% coverage), with overall vinyl jacket.

C. Low voltage signal (potentiometer and RTD) cable shall be cabled 3-conductor, 600 V, polyethylene insulated, aluminum/polyester tape shielded with No. 18 AWG tinned copper drain wire (100% coverage), with overall vinyl jacket.

2.03 WIRE AND CABLE MARKERS

A. Wire and cable markers shall be as manufactured by the W. H. Brady Co., Thomas & Betts Co., 3M Co. or approved equal.
PART 3  EXECUTION

3.01  INSTALLATION

A. All conductors shall be carefully handled to avoid kinks or damage to insulation.

B. All wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) shall be uniquely identified at each end with wire and cable markers.

C. Lubrications shall be used to facilitate wire pulling. Lubricants shall be U.L. approved for use with the insulation specified.

D. Shielded instrumentation wire shall be installed from terminal to terminal with no splicing at any intermediate point.

E. Shielded instrumentation wire shall be installed in rigid steel conduit and pull boxes that contain only shielded instrumentation wire.

F. Shielding on instrumentation wire shall be grounded at the transmitter end only.

3.02  TESTS

A. All 600-volt wire insulation shall be tested with a megohm meter after installation. Tests shall be made at not less than 500-volt. Submit a written test report of the results to the Government Site Representative.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Motors furnished under other Sections of these specifications shall be in conformance with the requirements listed in this Section unless otherwise noted.

1.02 SUBMITTALS

A. Submittal of motor data for acceptance shall include complete nameplate data and test characteristics in accordance with NEMA Standard MGI-12.54 "Report of Test Form for Routine Tests on Induction Motors" and, in addition, the following for motors typical of the units furnished:

1. Efficiency at 1/2, 3/4, and full load.
2. Power factor at 1/2, 3/4, and full load.
3. Motor outline, dimensions and weight.
4. Descriptive bulletins, including full description of insulation system.
5. Bearing design data.
6. Power factor correction capacitor rating and type.

1.03 STANDARDS

A. Motors shall be built in accordance with IEEE Standards, NEMA Standard MGI, latest revision, and to the requirements specified herein. Where a conflict exists, these Specifications shall take precedence.

1.04 TESTS

A. Routine tests shall be performed on representative motors, and shall include the information described on NEMA MGI-12.54 "Report of Test Form for Routine Tests on
Induction Motors.” Efficiency shall be determined in accordance with IEEE Publication Number 112, Method B. Power factor shall be measured on representative motors.

1.05 TYPE

A. Motors specified herein are three-phase, squirrel-cage induction type for 1/2 horsepower and above; single-phase types for less than 1/2 horsepower, unless otherwise noted on the Contract Drawings.

PART 2 PRODUCTS

2.01 RATING

A. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating.

B. The motor shall not be required to deliver more than its rated nameplate horsepower; at unit (1.0) service factor, under any condition of mechanical or hydraulic loading.

C. All motors shall be continuous time rated suitable for operation in a 40°C ambient unless noted otherwise.

D. Specific motor data such as HP, RPM, enclosure type, etc., is specified under the detailed specification for the mechanical equipment with which the motor is supplied.

2.02 ENCLOSURE TYPES

A. Motors specified herein will be totally enclosed fan-cooled, except for electric heater blower motors. Heater blower motors shall be the standard supplied by the heater manufacturer.

2.03 NAMEPLATES

A. 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 MGI-10.38 or MGI-20.60, as applicable.
2.04 VACUUM-PRESSURE IMPREGNATED (VPI) INSULATION

A. Where specified herein, or under the detailed mechanical specification, motors shall be provided with vacuum-pressure impregnated insulation submersible pump motors.

2.05 SINGLE-PHASE MOTORS

A. General

1. Unless otherwise specified on the Contract Drawings, motors smaller than 1/2 horsepower 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.

B. Voltage

1. Motors shall be rated for operation at 115 volts, single-phase, 60 hertz.

C. Enclosure

1. Motors shall be totally enclosed in conformance with NEMA Standard MGI-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 MGI-12.32, Design "N."

D. Bearings

1. Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.
A. General

1. All motors 3/4 horsepower and larger shall be on a NEMA frame 143T or larger. One-half horsepower motors, and 3/4 horsepower motors rated 1,800 and 3,600 rpm, shall be 56 frame. Motors shall be designed and connected for operation on a 460-volt, 3-phase, 60-hertz alternating current system. Dual voltage (230/460) rated motors are acceptable.

Unless otherwise required by the load all motors shall be NEMA Design B, normal starting torque unless noted otherwise. Starting KVA/HP (locked rotor) shall not exceed code letter G as described in NEMA Standard MGI-10.37 for motors 20 horsepower and larger.

Motors shall be as manufactured by Westinghouse Electric Corporation, U.S. Motors, Louis Allis Corporation, or approved equal.

B. Bearings

1. Anti-friction motor bearings shall be designed to be regreaseable and initially shall be filled with grease suitable to ambient temperature of 40°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.

2. 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.
C. Insulation

1. Insulation systems shall be Class F, operated at Class B temperature rise and shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock.

2. Motors for outdoor service shall have vacuum/pressure impregnated epoxy insulation for moisture resistance.

D. Enclosures

1. Motors shall have a steel or cast iron frame and a cast iron or stamped steel terminal box, as specified below. 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 nonwicking, nonhygroscopic 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.

   a. Total Enclosed Fan Cooled: TEFC motors shall include steel or cast iron frame, cast iron end brackets, cast iron terminal box, Class F insulation, Class B temperature rise, 1.15 service factor (at 40°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.

E. High Efficiency Motors

1. Three-phase motors rated 1 horsepower and larger shall be of the high-efficiency type. Motors shall have a Guaranteed Minimum Efficiency not less than the values indicated in Table A. Efficiency values shall be based on tests performed in accordance with IEEE Publication Number 112, Method B. Motors with horsepower or rpms not listed shall conform to comparable standards of construction and materials as those for listed motors.
TABLE A

<table>
<thead>
<tr>
<th>Horsepower</th>
<th>3,600 rpm</th>
<th>Guaranteed Minimum Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,800 rpm</td>
<td>1,200 rpm</td>
</tr>
<tr>
<td>1</td>
<td>----</td>
<td>81.5%</td>
</tr>
<tr>
<td>1-1/2</td>
<td>78.5%</td>
<td>81.5%</td>
</tr>
<tr>
<td>2</td>
<td>81.5%</td>
<td>81.5%</td>
</tr>
<tr>
<td>3</td>
<td>80.0%</td>
<td>86.5%</td>
</tr>
<tr>
<td>5</td>
<td>86.5%</td>
<td>86.5%</td>
</tr>
<tr>
<td>7-1/2</td>
<td>84.0%</td>
<td>88.5%</td>
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<td>85.5%</td>
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</tr>
<tr>
<td>30</td>
<td>89.5%</td>
<td>91.7%</td>
</tr>
</tbody>
</table>

F. Power Factor Correction Capacitors

1. All single-speed motors over 5 horsepower (except motors powered from variable frequency drives) shall be provided with a heavy duty industrial type power factor correction capacitor selected, recommended, and furnished by the motor manufacturer to raise the motor power factor to approximately 95 percent. The capacitor shall be mounted on the equipment base plate adjacent to the motor and shall be connected to the motor junction box with liquid-tight flexible conduit.

2. Capacitors shall be dry film or liquid insulated, and shall be hermetically sealed in steel enclosures.

3. Capacitor enclosures shall be suitable for conduit connection.

4. Capacitors shall be as manufactured by Westinghouse Electric Corporation, Cornell-Dublier, Sprague Electric, or approved equal.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install all miscellaneous equipment as hereinafter specified or as shown on
   the Contract Drawings or as directed by the Government Site Representative.

1.02 APPLICATIONS

A. Equipment enclosures shall be NEMA Type 1A for indoor locations and NEMA Type 4
   for outdoor locations except where otherwise shown on the Contract Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disconnect Switches

1. Disconnect switches shall be heavy-duty, quick-make, quick-break, visible blades,
   600 volt, 3 pole with full cover interlock.

2. NEMA Type 4-enclosures shall be stainless steel.

3. Switches shall be as manufactured by the Square D Co., Westinghouse Electric
   Corp., General Electric Co. or approved equal.
B. Control Stations

1. Control stations shall be heavy-duty type, with full size operators.

2. NEMA Type 4 enclosures shall be stainless steel and NEMA 7 enclosures shall be cast aluminum. NEMA 4X enclosures shall be reinforced plastic. Enclosure types shall be as shown on the Contract Drawings or directed by the Government Site Representative.

3. Control stations shall be Class 9001 as manufactured by the Square D Company or as manufactured by Westinghouse Electric Corp., General Electric Co. or approved equal.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install a complete underground system as hereinafter specified and shown on the Contract Drawings.

1.02 RELATED WORK NOT INCLUDED

A. Excavation and backfilling, including gravel and sand bedding, is included in Division 2.

B. All concrete and reinforcing steel is included under Division 3.

PART 2 PRODUCTS

2.01 MATERIALS

A. Direct burial cables shall be arranged as shown on the Contract Drawings.

B. PVC coated rigid conduit shall be used where direct burial cable enters the control enclosure.

PART 3 EXECUTION

3.01 INSTALLATION

A. Direct burial cables shall be installed as shown on the Contract Drawings, and Article 300-5 of the 1990 National Electrical Code.

B. Minimum depth of cables shall comply with Table 300-5 of the 1990 National Electrical Code.
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish, install, and test the primary distribution switchboard hereinafter specified and as shown on the Contract Drawings.

B. All units and sections shall be U.L. labeled when possible.

C. The primary distribution switchboard shall be "POWER STYLE" type QED-1, as manufactured by Square D, or approved equal.

1.02 SUBMITTALS

A. Complete master wiring diagrams, elementary or control schematics, including coordination with other electrical devices operating in conjunction with the primary distribution switchboard and suitable outline drawings shall be furnished for approval before proceeding with manufacture.

B. Submittals shall include a bill-of-material listing conductor material and insulation type as well as other hardware and equipment to be furnished.

C. Where it is not explicitly shown and completely obvious from the outline drawings, the following items shall be verified in a written statement accompanying the shop drawings.

   1. Type of terminations used and the number of and size of conductors that can be accommodated.

   2. Bus material and type of plating.
3. Insulation and isolation of bus.


PART 2 PRODUCTS

2.01 RATING

A. The primary distribution switchboard shall be designated for 480-volt, 3-phase, 3-wire, 60-Hz. service.

B. Main disconnect switch rated for 2,500 amperes and fused for 1,600 amperes. Short circuit current rating, 200,000 amperes.

C. Branch circuit feeder disconnects rated for 600 amperes and fused for 600 amperes.

D. Main bus rating shall be a minimum of 1,600 amperes.

2.02 CONSTRUCTION

A. The primary distribution switchboard shall be standard metal-enclosed, free standing, deadfront structures, not more than 90 inches in height, and fabricated from formed sheet steel of not less than No. 14-gauge thickness. The enclosure shall be NEMA 1.

B. Formed removable closure plates shall be used on the front, rear, and sides. All closure plates are to be single tool, screw removable.

C. Ventilation shall be provided where required.

D. Each section shall include a single-piece removable top plate.

E. The primary distribution switchboard shall be designed for against the wall mounting. All wiring, bus joints, and other mechanical parts requiring tightening or other maintenance shall be accessible from the front or top of the enclosure.

F. The primary distribution switchboard shall have engraved laminated nameplates screwed to the doors of each individual compartment.
G. The primary distribution switchboard shall be finished with ANSI Z55.1 No. 61 light gray enamel over a rust-resistant primer.

H. Two (2) ground lugs shall be provided, each capable of accepting a 4/0 bare copper grounding conductor.

2.03 LUGS

A. The main primary switchboard distribution panel incoming disconnect switch shall be capable of accepting six (6) 500 KCMIL type RHW conductors per phase.

B. Each feeder disconnect switch to the motor control centers shall be capable of accepting two (2) 500 KCMIL type RHW conductors per phase.

2.04 COMPONENTS

A. The main disconnect device shall be a fused bolted pressure switch. Fuses for the bolted pressure switch shall be provided by the manufacturer, along with 100 percent spares.

B. An ammeter and voltmeter shall be mounted in the door and supplied with the appropriate transformers and selector switches as required.

C. The switchboard group-mounted fusible branch devices are to be totally front accessible and front connectable. The fusible connections to the distribution panel bussing shall be of the “blow-on” design such that the connections grip the bus bars firmly under high-fault conditions. Fuses for the switches shall be provided by the manufacturer, along with 100 percent spares.
PART 3 EXECUTION

3.01 INSTALLATION

A. The primary switchboard distribution panel shall be bolted to the channel sills embedded in the concrete on the two longest sides. The sills shall be the full length of the panel and shall be installed level in all directions.

B. Field installed wiring shall be neatly grouped, tagged, and manufacturer's cable bending radiiues shall be strictly followed.

C. The panel shall be maintained in an upright position at all times. Lifting shall be at the floor sills or at the top mounted lifting angle.

D. The panel shall be protected against damage at all times. Any damage to the paint shall be carefully repaired using touch-up paint furnished by the panel manufacturer.

3.02 TESTS AND CHECKS

A. Megger terminals and buses for grounds after disconnecting devices sensitive to megger voltage.

B. Check all mechanical devices for proper operation.

C. Vacuum clean all interior parts.

3.03 SPARE PARTS

A. Complete complement of power fuses.

B. One (1) gallon of touch-up paint in four (4) 1-quart containers.

END OF SECTION
SECTION 16500
LIGHTING SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install complete lighting systems including lighting fixtures, receptacles, switches, and all necessary accessories and appurtenances required as hereinafter specified and shown on the Contract Drawings.

1.02 STANDARDS

A. All lighting fixtures shall be in accordance with the national 1990 Electrical Code and shall be constructed in accordance with the latest edition of the Underwriters Laboratories "Standards for Safety, Electric Lighting Fixtures." All lighting fixtures shall be Underwriters Laboratories labeled.

PART 2 PRODUCTS

2.01 MATERIALS

A. Conduit shall be as specified under Section 16110.

B. Wire shall be as specified under Section 16120.

C. Switches

1. Wall switches shall be of the indicating, toggle-action, flush-mounting quiet type. All switches shall conform to Federal Specification W-S-896-D.
2. Wall switches shall be of the following types and manufacturer.
   

b. Double-pole: Arrow-Hart, Catalog No. 1992, or equal by Harvey Hubbell, Inc.; Pass & Seymour, Inc.; or approved equal.

c. Three-way: Arrow-Hart, Catalog No. 1993, or equal by Harvey Hubbell, Inc.; Pass & Seymour, Inc.; or approved equal.

D. Receptacles

1. Wall receptacles shall be of the following types and manufacturer.


c. Weatherproof and Corrosion-Resistant, Duplex, 20A, 125V, 2P, 3W, with Cover: Crouse-Hinds Company, Catalog No. WLRD-5-20, or equal by Harvey Hubbell, Inc.; Pass & Seymour, Inc.; or approved equal.


E. Device Plates

1. Plates for flush mounted devices shall be of the required number of gangs for the application involved and shall be 302 (18-8) high nickel stainless steel of the same manufacturer as the device.

2. Plates for surface-mounted device boxes shall be of the same material as the box.
F. Lighting Fixtures

1. Lighting fixture types shall be as shown on the “Lighting Fixture Schedule” on the Contract Drawings. The catalog numbers listed are given as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers will be acceptable.

G. Lamps

1. Fluorescent lamps shall be medium bi-pin and recessed double contact, rapid start, standard cool white and biaxial types all as shown on the “Fixture Schedule.”

2. Fluorescent ballasts shall be energy saving, Class P, rapid start, high power factor, CBM certified by E.T.L. and listed by Underwriters Laboratories, Inc., for operation on 120 volts or as shown on the “Lighting Fixture Schedule.”

3. High pressure sodium lamps shall be clear and of the size and type as shown on the “Lighting Fixture Schedule.”

4. High pressure sodium ballasts shall be of the constant wattage type of the correct size and voltage for the fixture it is to serve as shown on the “Lighting Fixture Schedule.” All ballasts shall be as manufactured by Advance Transformer Company, General Electric Company, Jefferson Electric Company or approved equal.

5. Incandescent lamps shall be inside frosted, extended service, 2,500-hour life with medium base.

6. All lamps shall be of one manufacturer and shall be as manufactured by Sylvania Electric Products, Inc., General Electric Company, North American Philips Lighting Corporation or approved equal.
H. Flexible Fixture Hangers

1. Flexible fixture hangers used in nonhazardous areas shall be type ARB and flexible fixture supports used in hazardous areas shall be type ECHF as manufactured by the Crouse-Hinds Company or equal by Killark Electrical Manufacturing Company, Appleton Electric Company or approved equal.

I. Lighting Contactor

1. Lighting Contactors shall be of the electrically operated, mechanically held type in NEMA 1 enclosures of the number of poles as called for on the Contract Drawings.

2. Contactors shall be rated for 25A-600-volt contacts with 120-volt operating coil and be similar and equal to Automatic Switch Company 917 series, or equal by Allen Bradley Company, Westinghouse Electric Corporation or approved equal.

J. Lighting Control Time Switches

1. Time switches for the control of lighting shall have astronomic dials, reserve power and be similar and equal to the following types.

   a. Where time switch is indicated for SPST maintained control, it shall be Tork Time Controls Catalog No. 7100ZL 120-volt, or equal by Paragon, Intermatic or approved equal.

   b. Where time switch is indicated for DPST maintained control, it shall be Tork Time Controls Catalog No. 7202ZL 208-volt, or equal by Paragon, Intermatic or approved equal.

K. Emergency Lighting Battery Units

1. Emergency lighting units shall be fully automatic with 12-volt lead acid batteries. Units shall be designed for 120-volt, 60-Hertz input and have a sealed mercury relay, solid state charger, ready/off switch, press-to-test switch, amber "ready" light, volt meter, and required number of supervisory relays.
2. Emergency lighting units shall be Emergency Lighting and Systems, Inc. series 125C or equal by Chloride, Inc., Dual-Lite or equal of capacities as indicated on the Contract Drawings and be complete with all necessary mounting hardware.

3. Emergency lighting units shall each be equipped with a time delay relay to maintain emergency lighting in H.I.D. source lighted areas for 5 minutes after return of normal power.

4. Remote adjustable, wall mounting lighting heads shall each have 12-watt halogen lamps and be Emergency Lighting and Systems, Inc., model RDQ or equal by Chloride, Inc., Dual-Lite or approved equal.

5. Remote flush ceiling mounted lighting heads shall each have a 28-watt, 32 C.P. lamp and be Emergency Lighting and Systems, Inc., model RNF or approved equal by Chloride, Inc., Dual-Lite or approved equal.

6. Remote adjustable, wall mounting lighting heads for Class 1, Division 1, Group D hazardous areas shall each have a 25-watt sealed beam lamp and be Emergency Lighting and Systems, Inc., model RXPS or equal by Chloride, Inc., Dual-Lite or approved equal.

7. Remote adjustable, wall mounting, vaportight lighting heads each with 25-watt sealed beam lamps and be Emergency Lighting and Systems, Inc., model RVT or approved equal by Chloride, Inc., Dual-Lite or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each fixture shall be a completely finished unit with all components, mounting and/or hanging devices necessary, for the proper installation of the particular fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.

B. Flexible fixture hangers shall be used for all pendant-mounted fixtures.
3.02 REPLACEMENT

A. Lamps (except for H.I.D.) used during the building construction, prior to two weeks from completion of the work, shall be removed and replaced with new lamps.

3.03 CLEANING UP

A. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Government Site Representative.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install a complete grounding system in strict accordance with Article 250 of the 1990 National Electrical Code and as hereinafter specified and shown on the Contract Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Conduit shall be as specified under Section 16110.

B. Wire shall be as specified under Section 16120.

C. Ground rods.

1. Ground rods shall be 3/4" x 10 ft. copper clad steel.

D. Grounding conduit hubs shall be malleable iron type similar to Thomas and Betts Co. Cat. No. 3940 (3/4-in conduit size) or equal by Burndy, O.Z./Gedney Co., or other approved equal, and of the correct size for the conduit.

E. Water pipe ground clamps shall be cast bronze saddle type, similar to Thomas and Betts Co. Cat. No. 2 (1/2-inch, 3/4-inch, or 1-inch size) or equal by Burndy, O.Z. Gedney Co., or other approved equal, and of the correct size for the pipe.

F. Buried grounding connections shall be made with an exothermic welding system.
PART 3 EXECUTION

3.01 INSTALLATION

A. Grounding electrode conductors shall be run in rigid steel conduits. The protecting conduits shall be bonded to the grounding electrode conductors at both ends. Do not allow water pipe connections to be painted. If the connections are painted, they shall be dis-assembled and re-made with new fittings.

B. Grounding conductors shall be run with feeders as shown on the Contract Drawings.

C. Structural steel shall be bonded to the distribution equipment ground bus as shown on the Contract Drawings.

D. Conduits stubbed-up below a motor control center shall be fitted with insulated grounding bushings and connected to the motor control center ground bus. Boxes mounted below motor control centers shall be bonded to the motor control center ground bus. The grounding wire shall be sized in accordance with Table 250-94 of the 1990 National Electrical Code, except that a minimum No. 12 AWG shall be used.

E. Liquid tight flexible metal conduit in sizes 1-1/2-in. and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps.

F. Lighting transformer neutrals shall be grounded to the nearest available grounding electrode.

G. Grounding electrodes shall be driven as required.

H. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and similar items shall be grounded.
I. Exposed connections shall be made by means of approved grounding clamps. Exposed connections between different metals shall be sealed with an oxidation resistant paint.

J. All underground conductors shall be laid slack and where exposed to mechanical injury, shall be protected by pipes or other substantial guards. If guards are iron pipe or other magnetic material, conductors shall be electrically connected to both ends of the guard. Connections shall be made as hereinbefore specified.

K. Care shall be taken to insure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

3.02 TESTS

A. Test the ground resistance of the system. All test equipment shall be provided under this Section and approved by the Government Site Representative. Dry season resistance of the system shall not exceed five ohms. If such resistance cannot be obtained with the system as shown, provide additional grounding as directed by the Government Site Representative.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish, install, and place in operating condition an electrically operated, electrically supervised, non-coded Fire Alarm System as covered by these specifications, to be wired, connected, and left in first class operating condition. All equipment shall be approved by a nationally recognized testing laboratory such as UL or FM for its intended use.

B. The System shall be complete in every respect including all necessary equipment shown or not shown on the Contract Drawings to perform the functions relative to the system operation. All manufacturer's published specifications shall be considered as part of this specification even though they may not be shown in complete detail. The Fire Alarm manufacturer shall furnish the services of a factory trained Technical Representative to supervise the installation of the system and to verify that the system has been installed and is functioning properly.

1.02 OPERATION

A. The activation of a manual station or automatic detector shall cause its respective zone lamp to flash on the Fire Alarm Control Panel and sound all signals in a continuous ringing manner. In addition a signal shall be sent to the remote station monitor panel via dedicated hard copper telephone lines. All fees and associated equipment needed to complete this connection shall be considered a part of this specification and shall be provided.

B. Any abnormal condition, such as power failure, open circuit, or a grounded conductor shall cause the system trouble signal to sound and the trouble LED to glow indicating the type of trouble that exists. The trouble signal may be silenced by momentarily depressing the trouble silence switch, but the trouble LED shall glow until the trouble condition has been corrected. In addition, the trouble signal shall be sent to the
remote station monitor panel via the same dedicated hard copper telephone line listed in paragraph A. above. Once the trouble has been corrected the trouble LED shall be extinguished and the Fire Alarm System shall return to the normal state without any operator intervention.

C. The system shall normally operate from a 120VAC 60 Hz source however, standby batteries shall be provided to operate the system during power outages. Batteries shall be sized to operate the Fire Alarm System in the standby mode for a minimum of 24 hours and in the alarm mode for a minimum of 5 minutes at the end of the 24 hour period.

PART 2 PRODUCTS

2.01 EQUIPMENT

Provide the following equipment:

A. FIRE ALARM CONTROL PANEL: Furnish and install, where shown on the Contract Drawings, a Fire Alarm Control Panel. The cabinet shall be constructed of code grade steel and shall be suitable for surface mounting. The cabinet door shall be lockable and shall have a transparent window to allow for viewing of the various modules, LED’s, and switches. Simplex Time Recorder Type 4001-9403 by HoneyWell, ADT or approved equal.

The control panel shall be microprocessor based and shall be UL Listed to meet the requirements of Article 760 of the 1990 National Electric Code for Power Limited Systems. It shall contain Class “B” independently supervised initiation circuits so that a fault in any one zone shall not affect the operation of any other zone.

The Central Processing Unit shall contain four Class “B” Initiating Circuits, one Class “B” Signal Circuit, two SPDT Auxiliary Alarm Relays, one SPDT Auxiliary Trouble Relay, and a transient suppressed Municipal Connection Circuit with selectable outputs for 24VDC reverse polarity, local energy, shunt master box, or simple form “C” contact output. The CPU shall contain LED indicators for system trouble, city trouble, power trouble, ground trouble, and power on. It shall contain manual control switches for system reset, alarm silence, trouble silence, and city disconnect. Alarm and trouble
conditions shall be indicated at the operator’s panel by the tone alert and alarm or trouble LED’s.

For customer convenience, the Central Processing Unit of the system shall be capable of being programmed to any of the following functions:

**Alarm Verification** - The activation of any system smoke detector shall initiate an Alarm Verification operation whereby the panel shall reset the activated detector and wait for a second activation. If, after reset, a second alarm is reported from the same or any other smoke detector within one minute the system shall process the alarm. If no second alarm occurs within one minute the system shall resume normal operations. The Alarm Verification shall operate only for smoke detectors. Other activated initiating devices on the same or any other zone shall be processed immediately.

**March Time Code** - Causes the signals to operate at a cadence of 120 or 20 beats per minute.

**Temporal Code** - Causes the signals to pulse .5 seconds on, .5 seconds off, .5 seconds on, .5 seconds off, .5 seconds on, 2.5 seconds off, then repeat.

**Simple Code** - Causes the signals to continuously signal the zone number. For example, an activated device on Zone 2 causes the signals to pulse twice. Zone 3 three times.

**Alarm Silence Inhibit** - Disables the Signal Silence and System Reset Switches for 1, 3, or 5 minutes.

**Time Limit Cutout** - Automatically silences the signals after sounding for a predetermined time.

**System Walk Test** - Activating an initiating device shall cause the signals to sound one round of simple code identifying the zone number without actuating the municipal connection or auxiliary alarm outputs and will automatically reset. Momentarily opening an initiating device circuit shall cause the signals to operate for 4 seconds, thereby testing electrical supervision of the installation wiring.

All of the above functions shall be stored in non-volatile memory and shall be dip-switch selectable.
B. **MANUAL PULL STATIONS:** Furnish and install, where shown on the Contract Drawings, all Manual Pull Stations. Station shall be constructed of high impact red lexan and shall operate with or without glass rod. Once activated, the pull station handle shall remain at a 90 degree angle from the front of the station to provide visual indication as to which pull station was activated. Manual station shall be suitable for surface mounting. Manual pull station and back box to be Simplex Time Recorder Type No. 2099-9201 and 2975-9178 by Honeywell, ADT or approved equal.

C. **SMOKE DETECTORS:** Furnish and install, where shown on the Contract Drawings, all Photoelectric Smoke Detectors with 135 degree thermal element. All smoke detectors shall be U.L. Listed to standard 268 for the control equipment to which it is connected. Detectors shall be equipped with self-compensating circuitry to provide for maximum stability against effects of aging, dust, and film accumulation. The photoelectric light source shall be an LED. Each detector shall contain a red LED which shall pulse to indicate power on and which shall glow continuously to indicate alarm. A magnetically operated test feature shall be provided capable of simulating the maximum amount of smoke necessary for alarm without having to generate actual smoke. The sensitivity of the detectors shall be factory calibrated for 2.0% per foot smoke obscuration density. Smoke detectors to be Simplex Time Recorder Type 2098-9202 Photo Electric by Honeywell, ADT or approved equal.

D. **ALARM HORN:** Furnish and install, where shown on the Contract Drawings, the Alarm Horns. Units shall be suitable for surface mounting to a 4-inch square back box. They shall be red in color and shall be rated for 87 db @ 10 feet. Simplex Time Recorder Type 2901-9838 and a 2975-9006 box by Honeywell, ADT or approved equal.

E. **REMOTE STATION MONITOR PANEL:** Furnish and install (location to be within 5 miles of main Fire Alarm Panel) Remote Station Receiving Unit. Unit shall be surface mounted and contain a minimum of four module slots with one active and three spare. The unit shall contain an alarm lamp and a trouble lamp for each module slot. It shall also contain a normal power and standby power status lamp, an alarm silence sonalert and a 12VDC output for remote signal devices. The unit shall contain an internal nicad battery to supply power in a main power loss condition. All electronics shall be mounted in a red lockable surface mounted enclosure which is expandable to 10 module slots should further additions require the expansion. Panel to be Simplex Time Recorder Type 2088-8001 by Honeywell, ADT or approved equal.
PART 3 EXECUTION

3.01 INSTALLATION

A. The system wiring within the building shall be No. 14 AWG Type XHHW except for conductors connected to 120 volt power supplies which shall be No. 12 AWG Type XHHW.

B. Final connections in the fire alarm system shall be made under the direct supervision of an authorized representative of the manufacturer. Upon completion of the installation, the manufacturer shall check and test the entire system with the Government Site Representative and to his satisfaction.

C. Provide the Government with wiring diagrams including terminal to terminal designations, complete equipment specifications and complete sequence of operation for both subsystems.

D. System manufacturer shall warranty all equipment for a period of one year upon acceptance of the system by the Government Site Representative.

E. Instructions shall be given to Government personnel on the proper operation of the Security Subsystem.

END OF SECTION
SECTION 16722
SECURITY ALARM SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish, install, and place in operating condition an electrically operated, electrically supervised, Security Alarm System (hereinafter called the System) as described herein. The system shall include, but not be limited to: Control Panel, power supplies, security sensors, stand-by battery and automatic charger, conduit, wire, fittings, accessories and work as required to provide a complete operating system. All components shall be listed by Underwriters Laboratories for security system use.

B. The security alarm system shall monitor the integrity of all alarm initiating circuits, and shall be provided with automatically charged standby batteries to maintain system operation for 4 hours in the normal supervisory mode plus have sufficient capacity to operate in the alarm mode for 5 minutes at the conclusion of this supervisory time period. Batteries shall be supervised for connection to the system and a low voltage threshold. The automatic battery charger shall be capable of charging fully discharged system batteries to 100 percent in 8 hours.

C. Location of the control panel, alarm initiating devices, alarm indicating devices and other accessories shall be as shown on the Contract Drawings.

1.02 OPERATION

A. The system shall be comprised of the number of zones shown on the Contract Drawings. Zones shall be programmable for Instant, Delay, Day Supervisory, Silent, Priority (non-shunttable). Loop Response Time shall be programmable. System shall detect faulty Read Only Memory (ROM) on power up. System shall be continually supervised by a watch dog Microprocessor Timer.

B. The system shall be armed, disarmed, reset, by the use of a remote key switch. The system shall be programmed by the use of a four wire multiplex keypad. The system
shall provide "fail safe arming" preventing arming of the system if a zone has been violated or is ajar.

C. Functional parameters, such as signaling shall be fully programmable.

D. Actuation of any zone shall cause the following to occur:

1. Sound the exterior siren.
2. Send a signal to the Remote Station Monitor Panel provided with the Fire Alarm System in Section 16721 via dedicated hard copper telephone lines.

E. Acknowledgement of alarms or troubles, in conjunction with interrogation of other systems activity (i.e. alarm memory, bypassing of zones, etc.) shall require the use of a Personal Authorization Code (PAC) number to be entered in the keypad.

F. Provision for up to 8 user PAC codes shall be utilized with the system. Programming of these codes shall be field programmable into EEPROM memory without the use of any special programming tools. Programming will occur through the systems keypad. A user programming code will be required to make such changes. The keypad shall provide a means to verify programmed instructions through binary information displayed by the system's status indicators. No special displays or other associated hardware will be permitted to review program contents. Power outages or complete battery discharge shall not affect programmed field instructions.

G. The Control Panel primary power source and incoming telephone lines shall be protected from lightning, power surges, voltage spikes and transient or RF interference with a combination of zener overvoltage transient suppressors, R/C filters, ferrite beads and spark gaps.

H. Any zone shall be programmable for exit/entry time delays (1 - 255 seconds), providing a warning tone when in the timing sequence.

I. During a daytime "Disarmed" condition, activations of all door switches or any initiating alarm appliance shall be indicated through the system status indicators. The system ready lamp will extinguish. If the panel is "armed" these appliances will activate the control, sound the signals and alert the monitoring station via telephone lines.
J. Signal cut off time shall be programmable from 1 - 255 minutes.

K. Two SPDT relays shall be provided in the control to provide the reverse polarity circuit to the remote station monitor panel.

L. System alarms shall be retained in EEPROM memory until reset using the PAC number. Complete power outage shall not affect alarm memory recall.

PART 2 PRODUCTS

2.01 EQUIPMENT

Provide the following equipment:

A. SECURITY CONTROL PANEL: Provide an Eight Zone Security Control Panel to be surface mounted as indicated on the Contract Drawings. Control panel shall have built-in battery backup and shall provide up to 900 ma to power auxiliary devices. Voltage shall be regulated at 13.8 volts DC. Automatic system shutdown will occur at 7.5 volts DC to prevent false alarming. During alarm conditions up to 2.5 amps or power shall be available to drive sirens and auxiliary functions. Control panel shall be provided with a two (2) sound siren driver.

Control panel to be Simplex Time Recorder type 3001-9001 or equal as manufactured by Honeywell, ADT or approved equal.

B. CONTROL KEYPAD: Keypad to be mounted on the control panel door. The keypad shall be used for system set up, programming, and annunciation.

Keypad to be Simplex Time Recorder to type 3001-9801 by Honeywell, ADT or approved equal.

C. KEYSWITCH: Furnish and install, where shown on the Contract Drawings, a keyswitch for arm/disarm control and reset of the system. It shall contain a red armed LED and a green ready LED. The keyswitch shall be a SPDT type with momentary action. Provide a quantity of 6 keys with the keyswitch.
Keyswitch to be Simplex Time Recorder type KR-722/KM-107 by Honeywell, ADT or approved equal.

D. SYSTEM POWER SUPPLY: The Security Control Panel primary power supply shall be a 18 VAC 35 VA Class II transformer. The Security Control Panel secondary power supply shall be a 12 VDC 8 AH sealed lead-acid rechargeable battery. The battery shall be protected by an automatic circuit breaker. When initially connected to battery power alone, the Command Processor control panel shall be protected by a cutoff relay until manually started or primary power is applied. The secondary power shall be float charged at 13.8 VDC at a maximum of 1.2 amps. The control panel shall supervise the secondary power source by periodically placing a load across the battery while the primary source is available. If the voltage falls below 11.2 VDC a low battery fault shall be detected. If the primary power source is not available, a low battery fault shall be detected any time the voltage falls below 11.2 VDC. The secondary power supply shall be automatically disconnected from the system when the primary power supply is not available and the secondary power supply drops to 7.5 VDC.

E. MAGNETIC DOOR CONTACTS: Surface Mounted Industrial Wide Gap Magnetic Contacts with armored cable leads on door as shown on the Contract Drawings. The switch and housing shall be made of brushed anodized aluminum and the contacts shall be rhodium plated for long life. The housing shall be hermetically sealed to eliminate corrosion problems. Provide a type 2760-9097 (Sentrol type 1092ASTR) switch for the equipment overhead door. Magnetic door contacts to be Simplex Time Recorder type 2760-9082 and 2760-9087 by Honeywell, ADT or approved equal.

F. OUTDOOR SIREN/SPEAKER: Provide High Powered Siren/speaker where shown on the drawing. The siren/speaker shall be surface mounted in a type 3009-9502 Tamper-Resistant Enclosure. It shall be capable of supplying 125 db at 4 ft. and shall be provided with closed loop tamper circuit in the speaker cable providing protection against removal or cutting. The enclosure shall be louvered and shall have rust-resistant baked enamel finish. Two tamper switches shall be included and wired to a loop on the system for protection against unauthorized tampering. Siren/speaker to be Simplex Time Recorder type 3009-9504 by Honeywell, ADT or approved equal.

G. REMOTE STATION MONITOR PANEL ADDITION: Furnish and install an additional zone module in the Remote Station Monitor Panel provided under Section 16721 of this
specification to be used for monitoring the security system. This REMOTE PANEL will be located within 5 miles of the system security control panel.

PART 3  EXECUTION

3.01  WIRING

A. The electrical contractor shall furnish and install in accordance with the manufacturer's instructions, all wiring, conduit, raceways, outlet boxes, and auxiliary equipment required for the installation of the system.

B. The wiring system shall meet the requirements of all applicable National, State, and local electrical codes. All wiring shall be copper and shall be No. 14 AWG minimum or as recommended by the equipment manufacturer. The number of the conductors shall be as shown or as required by the equipment manufacturer. All wiring shall be color-coded. All wires shall be tagged in all junction points and shall test free from grounds or crosses between conductors. The Contractor shall furnish and install all necessary outlet boxes and mounting boxes required.

C. Final connections in the Security Alarm Subsystem shall be made under the direct supervision of an authorized representative of the manufacturer. Upon completion of the installation, the manufacturer shall check and test the entire system with the Government Site Representative.

D. Provide the Government Site Representative with wiring diagrams including terminal to terminal designations, complete equipment specifications and complete sequence of operation for both subsystems.

E. System manufacturer shall warranty all equipment for a period of one year upon acceptance of the system by the Government Site Representative.

F. Instructions including programming shall be given to Government personnel on the proper operation of the security system.

END OF SECTION
PART 1  GENERAL

1.01  SCOPE OF WORK

A. Furnish and install all electric space heating units as specified herein and shown on the Contract Drawings.

1.02  APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

B. Federal Specification (Fed. Spec.):
   F-F-310B Filter, Air-Conditioning: Viscous Impingement and Dry Media, Replaceable

C. Air Movement and Control Association (AMCA) Publications:
   210-85  Laboratory Methods of Testing Fans for Rating
   300-85  Reverberant Room Method for Sound Testing & Errata of Fans

D. American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE) Publication:
   Handbook, Equipment (1983), & Errata

E. National Electrical Manufacturers Association (NEMA) Publication:
   ICS 6-1983  Enclosures for Industrial Controls and Including Rev 1 thru 3 Systems

F. National Fire Protection Association (NFPA) Publication:
   70-1990  National Electrical Code & Errata
   Int Am 90-1
   Int Am 90-2
   Int Am 90-3
1.03 GENERAL REQUIREMENTS

A. Standard Products: Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years. The experience use shall include applications of equipment and materials under similar circumstances and of typical design and rating. Equipment items provided shall be capable of being serviced by an organization that is, in the opinion of the Government Project Manager, reasonably convenient to the site.

B. Nameplates: A nameplate drawing shall be submitted and shall have details of the type, size, and material of proposed nameplates, method recommended for fastening to the mounting surfaces, and raised or engraving details proposed. Nameplates shall be identified by number. Location of nameplates shall be shown on equipment arrangement drawings, along with the nameplate number.

C. Codes: Unless otherwise specified all work shall be in accordance with NFPA 70

1.04 SUBMITTALS

A. Shop drawings shall be submitted in accordance with Section 01170 and shall consist of a complete list of equipment and material, manufacturer’s descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Shop drawings shall also consist of a control schematic, complete power and control wiring diagrams, device ratings an part numbers, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

1.05 DELIVERY AND STORAGE

A. Equipment placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust or other contaminants.
2.01 UNIT HEATERS (HORIZONTAL AND VERTICAL PROPELLER FAN TYPE)

A. Construction: Unit heaters shall have wattage, voltage, phase, Btu/hr output, cfm air delivery, number of steps, and mounting height as shown or as specified. Unit heaters 5 kW and larger shall be three-phase. Complete unit heater assembly shall comply with the requirements of the UL 1025 and the requirements specified. Each unit heater shall be provided with terminals for control circuits and a single source of power as necessary. Control transformers, where required, shall be factory installed and of adequate capacity. Electrical load for three-phase heaters shall be balanced between phases. Maximum discharge air temperature shall not exceed 140 degrees F when inlet air temperature is 60 degrees F.

B. Heating Elements: Heating elements shall consist of nickel-chromium heating wire embedded in magnesium-oxide insulating refractory and sealed in corrosion-resisting metallic sheath with fins. The ends of elements shall be sealed and enclosed in a terminal box, and element sheath shall be mechanically pressed after filling to ensure maximum magnesium oxide compaction. Sheath and fins shall be cast aluminum or steel with fins brazed to sheath. Castings shall be free from defects of any nature. Steel sheath and fins shall be corrosion protected by (copper) (high-temperature ceramic coating) (high-temperature aluminized finish). Heat transfer between sheath and fins shall be uniform. Fins shall be spaced a maximum of six per inch and fin surface temperature at any point shall not exceed 550 degrees F during normal operation. Elements shall be free from expansion noise and 60-cycle hum.

C. Enclosure: Heater fan, motor, and auxiliaries shall be contained in a housing. All metal surfaces of housing shall be not less than 18 US gauge. Housings shall have the manufacturer's standard factory baked enamel finish. All parts shall be rigidly braced with heavy steel plates or structural steel shapes to prevent vibration and maintain alignment. Housing design shall provide ready access to interior parts without unfastening housing from mounting bracket. Swivel mounting brackets shall be furnished with each heater for wall or ceiling mounting as indicated. Each unit heater shall develop the floor area coverage and air throw required by the heater layout shown. The floor area coverage and air throw data shall be included on the shop drawing submittal.
D. Louvers: Horizontal air discharge units shall have individually adjustable horizontal louvered to direct discharge air horizontally as desired. A louvered back, heavy grille, or wire guard shall be provided for inlet air. Vertical air discharge units shall be provided with individually adjustable louvered so that air-flow pattern can be adjusted in all directions. Discharge cones or diffusers shall be substituted where required.

E. Fans and Motors: Fans shall be the propeller type direct connected to fan motor, dynamically balanced, and designed specifically for unit heater application and low noise level. Sleeve type bearings shall have ample provisions for lubrication, oil reservoir, and shall be effectively sealed against loss of lubrication and entrance of dirt. Ball and roller type bearings shall be sealed, self-aligning and permanently lubricated. Fan motor shall be totally enclosed, continuous duty with built-in manually reset thermal overload protection. Motors 1/2 horsepower and larger shall be three-phase unless otherwise shown on the Contract Drawings. Single-phase motors shall be permanent split capacitor, capacitor-start, or shaded pole type. Motor shall operate from the same power supply as the heater, and at the same voltage unless a factory-furnished step-down transformer is provided. Motor speed shall not exceed 1800 rpm.

F. Limit Controls: Manual reset thermal overheat protection of unit shall be provided to protect against overheating of the unit and mounted in a convenient location.

G. Contactor: Unit shall have factory-installed magnetic contactor, for self contained thermostatic operation, which shall disconnect all ungrounded conductors to the heater. Contactor shall be rated for 100,000-cycle duty. A control transformer shall be provided when necessary to supply 120-volt thermostat control circuit for each heater.

H. Controls: Thermostat for pilot duty shall be provided in unit heater. Thermostat shall have an approximate range of form 55 to 85 degrees F and an operating differential of 3 degrees F or less. Wiring shall be provided to an interval terminal strip to extend to a "Fan Only" toggle switch.

I. Wiring: Heaters shall be furnished complete, factory prewired to terminal strips, ready to receive branch circuit and control connections. Power connections shall be 3 phase 460 volts and "Fan Only" wiring.
PART 3  EXECUTION

3.01 INSTALLATION

A. Installation of equipment shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Contract Drawings.

B. The electric space heating units shall be installed to avoid generation of objectionable noise or vibration when operating under normal design conditions.

3.02 INSPECTION AND TESTING

A. After the electric space heating units have been completely installed, the Contractor shall conduct, in the presence of the Government Site Representative, such tests as are necessary to indicate that the units conform to specifications. The Contractor shall supply all labor material and equipment as may be required to complete this field testing.

B. If the electric space heating performance does not meet these specifications, corrective measures shall be taken by the Contractor.

END OF SECTION
PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish, install and test the motor control centers as hereinafter specified and as shown on the Contract Drawings.

B. All units and sections shall be U.L. labeled when possible.

C. The motor control centers shall be 2100 series as manufactured by Allen Bradley, 8000 series as manufactured by General Electric Company, or Series 2100 as manufactured by Westinghouse Electric Corporation, Model 5 as manufactured by Square D Company, or approved equal.

1.03 SUBMITTALS

A. Complete master wiring diagrams, elementary or control schematics, including coordination with other electrical control devices operating in conjunction with the motor control centers and suitable outline drawings shall be furnished for approval before proceeding with manufacture. Due to the complexity of the control functions, it is imperative the above drawings be clear and carefully prepared to facilitate interconnections with other equipment. Standard preprinted sheets or drawings simply marked to indicate applicability to this Contract will not be acceptable.

B. Submittals shall include a bill-of-material listing conductor material and insulation type as well as other hardware and equipment to be furnished.
C. Where it is not explicitly shown and completely obvious from the outline drawings, the following items shall be verified in a written statement accompanying the shop drawings.

1. Type of terminal blocks used and that the removal of plug-in compartments can be performed without disconnecting or removing wires.

2. Silver plating of bus.

3. Insulation and isolation of vertical bus.


PART 2 PRODUCTS

2.01 RATING

A. The motor control centers shall be designed for 480-volt, 3-phase, 3-wire, 60-Hz. service.

B. The motor control centers shall be designed for a short circuit current of not less than 25,000 r.m.s. symmetrical amperes.

C. Circuit protective devices shall be rated for not less than the design short circuit rating. Series rated devices will not be acceptable.

2.02 CONSTRUCTION

A. Structure

1. The motor control centers shall be standard metal-enclosed, free-standing, deadfront structures, not more than 90 inches in height, and fabricated from formed sheet steel of not less than No. 14-gauge thickness. The enclosures shall be NEMA I. The motor control centers shall consist of vertical sections of equal height containing individual plug-in compartments. Compartments shall be isolated from each other by separate horizontal steel plates or by steel plates without openings that are a part of the compartment itself.
2. Plug-in compartments shall totally isolate enclosed equipment. All unused openings to the adjacent vertical wiring space shall be plugged. All openings used for wiring shall have insulating grommets.

3. Vertical sections shall be mounted on steel channel sills continuous on four sides, or with steel channel sills on two sides and end cover plates. Each compartment shall be provided with a hinged door of pan construction on the front and a door opening of sufficient size to permit ready removal of any of the equipment in the compartment. Interlocks shall be provided to prevent opening the compartment door when the disconnect device in the compartment is in the closed position. An interlock bypass device shall be furnished. Means of locking the disconnect device in the "Off" position shall be provided. Disconnect device operating mechanism shall not be attached to the compartment door.

4. All sections shall have the same structural features with provisions for the addition of similar sections at either end. Each compartment shall meet NEMA Standards for the control equipment installed and units of similar size shall be interchangeable.

5. Each section shall be provided with a horizontal wiring space which shall line up with a similar space in the adjacent section or sections, with openings between so that wires may be pulled the entire length of the control centers. There shall also be provided in each section a vertical wiring space with separate full height door.

6. The motor control centers shall be designed for against-the-wall mounting. All wiring, bus joints and other mechanical parts requiring tightening or other maintenance shall be accessible from the front or top.

7. The motor control centers shall have engraved laminated nameplates screwed to the doors of each individual compartment and wiring diagrams pasted inside each door. Compartments containing panel boards shall have a card holder on the inside of the door. Compartments containing motor starters shall each have an overload heater selection table pasted inside the door.
8. The motor control centers shall provide equipment of type, capacity and trip ratings for the loads shown on the Contract Drawings or otherwise specified. Minimum starter size shall be NEMA 1.

9. Construction shall be NEMA Class II, Type B or C. Insofar as possible, all devices and components used shall be of one manufacturer. The motor control centers shall be furnished as a completely factory-assembled unit where transportation facilities and installation requirements permit.

10. The motor control centers shall be finished with ANSI Z55.1, No. 61 light gray enamel over a rust resistant primer.

B. Buses

1. All buses shall be silver-plated copper. A continuous main horizontal bus shall be furnished. Main buses shall be rated as shown on the Contract Drawings.

2. Each vertical section shall have a full height vertical bus rated not less than 300 amperes. Vertical buses shall be insulated and isolated with glass polyester or equivalent continuous insulation. Taped buses will not be acceptable. Unused stab openings shall be plugged. Lower ends of vertical buses shall be insulated.

3. A 1/4-inch by 2-inch ground bus shall be furnished the entire length of the motor control center.

4. All buses except the ground bus shall be completely isolated by steel plates or insulating material.

C. Wiring

1. All wiring shall be copper.

2. Compartment wiring shall be to compartment mounted, plug-in terminal blocks that allow compartments to be withdrawn without having to remove wires from fixed terminal blocks.
3. Power wiring shall be black, control wiring shall be red, wiring energized from sources other than the starter control power transformer shall be yellow.

4. Control wiring size shall be not less than No. 14 A.W.G, stranded copper.

5. All control wiring shall be uniquely numbered at each end.

D. Signage

1. Each motor control center shall be furnished with a sign marked “DANGER - HIGH VOLTAGE - KEEP OUT.” Letters shall be not less than 1 inch high, 1/4-inch stroke. Signs shall be laminated plastic, engraved red letters with a white background.

2. All compartments with voltages from sources outside of the compartment shall have a sign on the compartment door marked “CAUTION - THIS UNIT CONTAINS A VOLTAGE FROM A SOURCE OUTSIDE OF THIS UNIT.” Letters shall be black on a high-visibility yellow background. Background shall be vinyl approximately 3 inches by 5 inches.

3. All compartments with capacitor-equipped component shall be provided with a warning label marked “CAUTION: THIS MOTOR CAPACITOR EQUIPPED.”

4. All compartments shall have a nameplate identifying the unit.

2.03 COMPONENTS

A. Combination Motor Starters

1. All motor starters shall be a combination motor circuit protector and contactor, 3-pole, 60-Hz, 600-volt, magnetically operated, of the types shown on the Contract Drawings. NEMA sizes shall be as required for the horsepowers shown on the Contract Drawings, but shall be not less than NEMA Size 1. Fractional size starters will not be acceptable. IEC rated starters shall have continuous current ratings listed in Table 2-321-1 of NEMA Standard Publication ICS 2-1978.

2. All motor starters shall have a 120-volt operating coil, overload relay in each phase and control power transformer.
3. All motor starters shall have 1-N.O. and 1-N.C. auxiliary contacts. Additional auxiliary contacts shall be furnished where shown on the Contract Drawings or as required by the control scheme.

4. Full voltage, nonreversing starters, shall be of plug-in design with stab-on connectors engaging the vertical buses.

5. Overload relays shall be adjustable, ambient compensated and manually reset by pushbutton in compartment door.

6. Where shown on the Contract Drawings, Class 10 overload relays shall be provided, and shall be ambient compensated, "quick-trip" type.

7. Control power transformers shall be sized for additional load where required. Transformer primary and secondaries shall be equipped with time-delay fuses. Control power transformers shall be connected to the load side of the controller disconnecting means.

8. Disconnect switch and circuit breaker operating mechanisms shall not be mounted on cubicle doors.

9. Motor circuit protectors shall be current limiting molded case type with adjustable magnetic trip only. They shall be specifically designed for use with magnetic motor starters. Motor circuit protectors shall have auxiliary disconnect contacts when used with starters having external control circuits or a separate switch shall be furnished. Motor circuit protectors shall be fully rated for the motor control center short circuit current.

B. Fused Disconnect Switches

1. Fused disconnect switches shall be fusible disconnect switch with Type J fuse clips. Power fuses to be provided for each motor application. This disconnect switch to be designed for the starter. The combination of starter, disconnect, and control transformer to be removable in on assembly.
PART 3  EXECUTION

3.01  INSTALLATION

A. The motor control centers shall be bolted to channel sills embedded in the concrete on the two longest sides. The sills shall be the full length of the motor control center and shall be installed level in all directions.

B. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported such that circuit terminations are not stressed.

C. The motor control centers shall be maintained in an upright position at all times. Lifting shall be only at the floor sills or the top mounted lifting angle.

D. The motor control centers shall be protected against damage at all times. Any damage to the paint shall be carefully repaired using touch-up paint furnished by motor control centers manufacturer.

3.02  TESTS AND CHECKS

A. The following minimum tests and checks shall be made before energizing the motor control centers.

1. Megger terminals and buses for grounds after disconnecting devices sensitive to megger voltage.

2. Remove all current transformer shunts after completing secondary circuit.

3. Install overload relay heaters based on actual motor nameplate current. If capacitors are installed between starter and motor, use overload relay heaters based on measured motor current.

4. Check all mechanical interlocks for proper operation.

5. Vacuum clean all interior equipment.

B. Adjust all motor circuit protectors and circuit breakers to their correct settings.
3.03 SPARE PARTS

A. The following spare parts shall be furnished.

1. Ten boxes of control power fuses of each size furnished.

2. One three-pole set of starter contacts for every 10 starters of each NEMA size installed (min. 1 set).

3. One starter coil for every 10 starters of each NEMA size installed (min. 1 coil).

4. Ten boxes of pilot lights.

5. Two NEMA size 1 starters and one NEMA size 2 starter.

6. Complete complement of power fuses.

END OF SECTION