ITEM IX - DUPLEX SUBMERSIBLE NON-CLOG SUCTION LIFT SEWAGE PUMPING STATIONS AND PIPING

9.01 Scope

(a) Sewage pumping stations shall consist of a minimum of 2 sewage pumps, associated controls with a complete SCADA system, piping, structures and a backup generator capable of powering the entire site. Three-phase power shall be provided to the site. Each pump shall be 5 HP minimum and capable of pumping the peak design flow.

Pump stations which will serve as future "regional" stations, i.e. serving significant large areas, will be reviewed on a case-by-case basis by the DISTRICT. These may have additional requirements to those listed in this specification.

- Design Basis: Each pump must be properly selected with the necessary characteristics to perform under the operating conditions shown on the pump station drawings. Pumps shall be selected so that they operate at, or close to, the Best Efficiency Point. The following pump operating conditions shall be shown on the plans or specified in the Special Conditions: Capacity (GPM) Peak and Average Daily Flow
- Total Dynamic Head (feet)
- Minimum Pump Efficiency (percent)
- Maximum Sphere passage (Inches)
- Maximum Motor Horsepower
- Motor voltage/Phase/Hertz
- Minimum Service Factor
- System and Pump Curve
- Pump Cycle and Run Times
- Forcemain Velocity
- Buoyancy

Pumps provided, including the spare pump and motor, shall be delivered pre-adjusted to meet the specified conditions.

(b) Preparation, grading and excavation of site, concrete and steel reinforcement, valves and piping, lighting, grassing and planting, miscellaneous metal work, and painting shall conform to the requirements of MSD's Standard Specifications.

(c) The Pump Station site and access road shall be a minimum of 2 feet above the 100 year flood elevation.

9.02 General

(a) Pumps, piping and other equipment shall be new and unused, designed for the service intended, and shall be suitable for installation and efficient operation within the space and under the conditions shown on the Plans and specified herein. All equipment shall be properly protected so that no damage or deterioration will occur during shipment or storage.

(b) All structural steel work shall comply with the requirements of the American Institute of Steel Construction Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.

(c) The CONTRACTOR shall furnish the services of a competent engineering representative of the manufacturer of the pumps to inspect their installation and supervise initial operation. Upon completion of such supervision, the manufacturer's representative shall provide the DISTRICT a signed certificate which states that the pumps have been checked; that they perform satisfactorily; and that they meet the requirements of the Specifications. This certificate shall show the name of the pump manufacturer and the name of the company or firm by which the representative is employed.

(d) The CONTRACTOR shall furnish the services of a competent engineering representative or the manufacturer of the standby generator to inspect the installation and supervise the initial start-up and operation. A complete 4 hour (min.), 100 percent load test shall be conducted during the start up. Load test shall be at rated generator load. Upon completion of standby generator startup, the manufacturer's representative shall provide the DISTRICT a signed certificate which states that the generator has been checked; that it performed satisfactorily; and that it meets the requirements of the Specifications. This certificate shall show the name of the generator manufacturer and the name of the company or firm by which the representative is employed.

(e) The CONTRACTOR shall furnish to the DISTRICT three (3) copies of drawings of equipment to be furnished; foundation plans, number and position of all anchor bolts, manufacturer's specifications, descriptive literature, complete electrical data and control diagrams, and operating and maintenance instructions. Three copies of performance curves shall also be furnished for the pumping equipment, showing the condition point, shut-off head, the impeller diameter, the pump speed, and the horsepower. Descriptive literature and operating and maintenance instructions shall be furnished at the same time equipment drawings are furnished. This material shall be furnished in suitable binders.

9.03 Spare Parts

The manufacturer shall furnish a complete set of spare parts per the

manufacturer's recommendation. At a minimum, spare parts shall include the following: One complete pump and motor assembly including corded cap, one flange guide, and one complete mechanical seal.

9.04 Warranties

The pumps shall be warranted to be free from defects in workmanship, design, and materials for a period of 1 year under normal use, operations, and service.

The pump seals shall be warranted for a minimum of 5 years from the date of shipment. Should the seals fail within the first year, the manufacturer shall be obligated, upon notification, to furnish new seals, without charge to the DISTRICT. The cost of replacement seals thereafter will be on a pro-rated basis as follows:

Months After Shipment	Percentage of New Seal Price
0-18	**0%**
19-31	**25%**
32-45	**50%**
46-60	**75%**

9.05 Submittals

(a) Submittals for Plan Review shall include detailed drawings as specified herein and design calculations. Design calculations shall include flow calculations, pump cycle time calculations, pump on/off and alarm level, anti-flotation calculations, and system curve showing operating point, efficiency, and required brake horsepower.

(b) The Design Submittal Checklist shall include but is not necessarily limited to the following items. The Engineer of Record shall verify these items are properly incorporated into the project, check each item, and sign/seal the checklist.

_____1. Three-Phase power is provided to the site.
_____2. 12 foot wide access road, with 2 foot shoulders and adequately designed ditches, and dedicated easements as applicable.
_____3. Turn-around outside the gate, as specified.
_____4. Access road, turn-around and site are paved, including 1 foot outside perimeter fence, and are adequately drained.
_____5. Site layout provides 5 feet (min.) clearance between perimeter fence and equipment.
_____6. Wet well is properly sized for 4 – 8 cycles per hour at design flow.
_____7. Wet well is designed to resist buoyant force, if applicable.
_____8. The pumps are the most efficient available among acceptable manufacturers.
_____9. A properly sized and designed magnetic flow meter is provided.
_____10. Pipe and valves and fittings meet MSD specifications.
_____11. All mounting hardware, flange bolts and hardware mounting bolts are stainless steel.
_____12. Guide rails and lifting cable or chain and cable hanger are stainless steel.
_____13. All ductile iron pipe is minimum Class 350.
_____14. All exposed piping, valves, and fittings shall be flanged. Pipe shall be flanged with threaded flanges.
_____15. Influent manhole with only one penetration into the wet well.
_____16. The wet well and valve vault hatches are of adequate size for equipment removal.
_____17. Valve vault hatches are of adequate size for entry, valve operation, and force main bypass connection.
_____18. If any equipment exceeds 2000 lbs., an electric winch hoist is provided with 115 volt weatherproof electrical outlet within 8 feet, with an adequate footing.
_____19. All power and control panels are housed in stainless steel NEMA 4X enclosures.
_____20. The support structure for power and control panels is stainless steel channel sections.
_____21. The site layout provides adequate clearance between the wet well and control panels and wet well and generator.
_____22. Adequate area lighting is provided.
_____23. Adequate enclosure fence is provided.
_____24. The wet well has a DI screened vent.
_____25. The force main drawings include a plan and profile view with maximum scales of 1" = 10' vertical and 1" = 50' horizontal.
_____26. Pump Station site and access road are above 100 year flood elevation.
_____27. One harnessed flange dismantling joint shall be provided on each pump discharge line in the valve vault.
_____28. One bypass valve on force main, including isolation valves.
_____29. Adequate emergency power generator in weatherproof enclosure with

sufficient capacity to run all pumps and equipment.

_____30. Measures to control odor problems if applicable.

_____31. Potable water supply with yard hydrant.

Engineer of Record's Certification that each of the above items has been properly addressed, and included in the plans as applicable:

_____ _____

Engineer of Record Date

ENGINEER'S SEAL SHALL BE AFFIXED

(c) Shop Drawing Submittal List (provide 3 copies for DISTRICT, CONTRACTOR and Engineer of Record).

Shop drawing submittals shall include but not necessarily be limited to the following materials and equipment:

Pump Station Wet Well	Main Circuit Breaker
Pumps	Fused Disconnect
Foundation Plan	Transfer Switch
Buildings	Disconnect Switch
Equipment Enclosures	Ultrasonic Level Control
Odor Control System	Conduit Seals
Wet Well Hatch	Electrical Conduits
DI Flanged Piping	Air/Vacuum Valves
Backup Elec. Generator	SS Structural Supports
DI Gasket Pipe	Pump Hoist
Force Main Pipe	Access Hatches
DI Fittings	Drain Piping w/Flap Valve
SS Bolts and Fasteners	FM Bypass Connection, 4" male
Pipe Paint	Yard Hydrant
Screened Vents	RP Backflow Preventer
Check Valves	Water Meter
External Swing Arm	Ladders
Gate Valves	Pump Control Panel
Plug Valves	Pump Hoist
Valve Vault	Telemetry Panel
Vault Hatches	Service Disconnect
Chain Link Fencing & Gate	Electrical Wiring
Heated Enclosure for BFP	Wire Trough
Transfer Switch	Area Light and Pole
Electrical Control Schematic	SCADA System
Harnessed Dismantling Joint	Magnetic Flow Meter

(d) Operation and Maintenance Manuals

The CONTRACTOR shall furnish three (3) complete sets of operation and maintenance (O&M) manuals, organized in a three-ring binder or suitable binders.

The O&M manual shall also be provided in electronic format, and shall include the following items, as installed:

1. Detailed pump drawings and parts list.
2. Pump system curve showing operating point, shut-off head, pump speed, efficiency, horsepower, and impeller diameter, pump model and serial number.
3. Manufacturer's specifications and descriptive literature, and regular maintenance schedules for all equipment.

4. Supplier's name, address, phone number, and fax number for all materials and equipment.
5. Wiring diagrams for all control and electrical panels. Diagrams shall show wiring added to interface with other panels and equipment. These diagrams shall also note conduits with numbering so wires can be traced. When relays are noted, they shall be identified as to location in the equipment.
6. The pump station manufacturer shall supply 3 complete sets of comprehensive written instructions to enable an operator to properly operate and maintain the equipment supplied. Content of the instructions shall assume the operator is familiar with pumps, motors, piping and valves but that he has not previously operated and/or maintained the exact equipment supplied.
7. The instructions shall be prepared as a system manual applicable solely to the pump station equipment and related devices supplied by the manufacturer, as specified herein. Instructions for any equipment for which the manufacturer has not supplied, but has made mounting or other provisions, shall also be provided.
8. The instructions shall include, but not be limited to, the following:

(a) Descriptions of, and operating instructions for, each major component of the complete pump package as supplied.

(b) Instructions on operation of the pumps and pump controls in all intended modes of operation.

(c) Instructions for all adjustments which must be performed at initial startup of pump equipment, adjustments required after the replacement of liquid level control system components, and adjustments as required in the course of preventative maintenance as specified by the manufacturer.

(d) Service instructions for major components not manufactured by the pump station manufacturer, but supplied by him in accordance with the Specifications. In such case, the literature supplied by the actual manufacturer shall be incorporated as an appendix.

(e) Electrical schematic diagram of the pump station as supplied, prepared in accordance with industry standards. Schematics shall illustrate, to the extent of authorized repair, pump motor branch, control and alarm system circuits, and interconnections among these circuits. Wire numbers shall be shown on the schematic. Schematic diagrams for individual components, not normally repairable by the station operator, need not be included and details for such parts shall not be substituted for an overall system schematic. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of an overall system diagram.

(f) Layout drawing of the pump station as supplied, prepared in accordance with good commercial practice, showing the location of all pumps,

motors, valves and piping.

(g) Operation and maintenance instructions shall be specific to the equipment supplied in accordance with these Specifications. Instruction manuals applicable to many different configurations of pump stations, and which require the operator to selectively read portions of the manual will not be acceptable. Operation and maintenance instructions which are limited to a collection of product literature without addressing overall pump station operation and maintenance will not be acceptable.

(h) Complete operation and maintenance manuals for emergency power generation system.

9.06 Public Utility Accounts for Pump Stations

The CONTRACTOR or Development Owner shall set up the accounts for all applicable utilities providing service to the pump station site, i.e. water, power, natural gas. The accounts shall be set up in the Development Owner's name and later transferred to the DISTRICT's name. In either case the Development Owner shall be responsible for payment of all utility bills until such time that the DISTRICT takes ownership of the pump station. The Development Owner shall provide verification that all accounts are in good standing at time of transfer of ownership to the DISTRICT.

9.07 Submersible Non-Clog Sewage Pumps

(a) Submersible non-clog sewage pumps shall be capable of handling raw, unscreened sewage and passing 3-inch diameter solids. The discharge connection elbows shall be permanently installed in the wet well along with the discharge piping. The pumps shall be automatically connected to the discharge connection elbows when lowered into place and shall be easily removed for inspection and service. Installation and removal of pumps shall not require personnel to enter the wet well. Sealing of the pump units to discharge connections shall be accomplished by linear downward motion of the pumps. The pump, with its appurtenances and cable, shall be capable of continuous submergence in water to depths of 231 feet without leakage.

(b) Each of the two submersible sewage pumps shall have the capacity, minimum efficiency, and motor size specified in the Special Conditions or on the Plans. The maximum pump motor speed shall be 1,800 rpm unless approved by the DISTRICT. Motors shall be suitable for 460 volt, 60 Hz, 3-phase operation.

(c) Pumps, motors, pump discharge connections, discharge elbows, guide rails, float switches and electrical cable, and pump guides shall be designed for Class 1, Groups C and D, Division 1, hazardous locations, as defined by the National Electrical Code and shall be so certified by an independent laboratory.

(d) All bolts, machine screws, nuts, lockwashers, and other hardware used in the assembly of discharge elbows, guide rails, pump guides, hoist chains, float cable connectors, and access frames and covers shall be of stainless steel.

(e) Pumps shall be constructed of cast iron which complies with the requirements of ASTM Specification A48, Class 30. All pump openings and passages, including impellers, shall be of adequate size to pass spheres at least three inches in diameter and trash of stringy material which commonly occurs in sanitary sewage. Impellers shall be the enclosed or open type having a minimum number of vanes and shall be of cast iron construction, dynamically balanced. Stainless steel impeller wearing rings with mating stainless steel case wearing rings shall be provided on the inboard side of open impellers. Impellers shall be mounted in the stainless steel motor shaft. An oil chamber and two mechanical seals shall seal the motor from the pump liquid. Moisture detection probes shall be mounted in the oil chamber which is interlocked with the motor to shut down the pump and turn on a warning light on the motor control center when moisture is present in the oil chamber. Thermistors mounted in the bottom of the stator housing may be used instead of the moisture detection probes. Mechanical seals shall consist of upper and lower seals. Upper seals shall have ceramic stationary faces and carbon rotating faces with stainless steel springs. Lower seals shall have tungsten carbide stationary and rotating faces with stainless steel springs. Discharge connections shall have contact surfaces of non-sparking materials. Discharge elbows shall be of cast iron with integral bases for anchoring and supporting pumps and piping. Flanges shall conform to the requirements of ANSI/AWWA Specification C110. The metal contact surfaces shall be of non-sparking materials. Pump guides shall be stainless steel. The entire pump units shall be designed for Class 1, Groups C and D, Division 1, hazardous locations, as defined by the National Electrical Code and shall be so certified by an independent laboratory, so that forced wet well ventilation and redundant cut-off switches are not required. A welded, stainless steel chain of adequate size shall be permanently attached to each pump. Provisions shall be made for attaching the upper end of each chain to the wet well access frame and cover.

(f) Submersible pump motors shall be designed for Class 1, Groups C and D, Division 1, hazardous locations as defined by the National Electrical Code and shall be so certified by an independent laboratory. Motors shall be explosion proof, squirrel cage induction type housed in an oil-filled cast iron watertight enclosure. The enclosure shall be sealed by O-rings and shall have rabbet joints with a large overlap. Cable leads shall be epoxy sealed. The motor shaft extension shall be stainless steel, impervious to the liquid and waste materials being pumped. All external hardware including motor nameplates shall be made of stainless steel. Motors shall be NEMA Design B: insulation shall be Special Class F rated for continuous duty in 40˚C liquids; shall have a 1.15 service factor; shall be equipped with winding thermostats; shall be capable of operating for 15 minutes in air at nameplate horsepower, and shall be capable of 15 starts per hour.

The pumps shall be furnished with power and control cords of sufficient length to connect to the motor control center. The pump motors shall be sized so that they will not be overloaded at their rated capacity at any point on the pump performance curve.

(g) The pump shall have a durable, attached nameplate to confirm that it is built in accordance with the Specification as to HP, voltage, phase and hertz.

(h) Submersible sewage pumps shall be manufactured by the DISTRICT's preferred vendors: Flygt, ABS, Yeoman-Clow, Grundfos. Pumps that are 30 HP or greater shall be reviewed on an individual basis.

9.08 Submersible Grinder Sewage Pumps

These pumps will only be allowed on a case-by-case basis.

9.09 Horizontal Self-Priming Centrifugal Suction Lift Pumps

These pumps will be reviewed on a case-by-case basis.

9.10 Emergency Power Generator

An emergency power generator shall be provided at the station that is adequate to continuously operate all equipment at the site at full development buildout. It shall be powered by natural gas. If natural gas is not available, a diesel powered generator shall be installed with a fuel tank sized for a minimum of 24 hour operation. The fuel tank shall be full at the time of acceptance by the DISTRICT. The generator shall have at least 5 feet clearance in all directions. A service disconnect shall be provided between the generator and power source. Detail drawings must show pad, anchoring, and all details needed to evaluate acceptability. Detailed manufacturer's information shall be provided. The generator shall be programmed to automatically start and run for one hour each week at a time to be determined by the DISTRICT. The generator shall be equipped with an automatic transfer switch, battery charger, computer cable, and computer software.

9.11 Guide Rails

Guide rails shall be of stainless steel which shall be attached to the access frame and cover by stainless steel brackets and anchors. The guide rail support shall be adjusted so that optimum vertical alignment can be obtained.

9.12 Access Frame and Cover

(a) The wet well and valve pit access frames and covers shall be double door hatches of all aluminum diamond plate construction reinforced for a 300 psi live load. The frames shall be extruded and have 316 S.S. hinges and 316 S.S. tamper resistant bolts/locknuts. The frame shall be cast into the concrete tops of the wet well and valve pit properly placed to facilitate removal of pumps and valves. They shall be of the sizes shown on the Plans or selected by the pump manufacturer. In no case shall access doors be less than that necessary to service valves and fittings within the pit. Entrance shall be by a removable key or post/staple for a padlock. A handle on the inside shall permit inside door opening. Submit detail drawing. Frames and covers located near traffic shall be traffic rated and approved by the DISTRICT.

(b) Door leaves shall be ¼-inch thick aluminum diamond plate reinforced for a 300 psi live load. The frame shall be extruded aluminum trough section with an integral anchor flange on all 4 sides. The frame shall include an EPDM odor reduction gasket that reduces the amount of odor that escapes from below the door and a 1 ½ -inch threaded drain coupling. The floor access door shall be equipped with a flush drop handle that does not protrude above the cover, and 316 stainless steel hold open arms with red vinyl grips that automatically lock the covers in the 90 degree open position. The door shall have 316 stainless steel hinges and 316 stainless steel tamper resistant bolts/locknuts. A staple for a padlock shall be supplied for security. Installation shall be in accordance with the manufacturer's attached instructions. The door shall be manufactured and assembled in the United States. Manufacturer shall guarantee the door against defects, materials and workmanship for a period of 10 years. The floor access door shall be Model TPD as manufactured by U.S. Fabrication, Inc. or pre-approved equal.

9.13 Motor Control Center

(a) The motor control center shall control the operation of all pumps. The motor control center shall contain starters for each pump, pump alternation and level sensing circuits, alarm circuits, and control devices as specified and as required. The motor control center shall also contain a 15 amp, 120 volt duplex receptacle.

(b) For starters less than 50 Hp, each pump starter shall be combination magnetic full voltage circuit breaker type with magnetic trip circuit breaker and thermal overload elements in each phase. The circuit breaker and overload elements shall be selected and set for the nameplate characteristics of the motor furnished and not "typical" values. The starter shall be UL listed for use on a system with available fault current of at least 22,000 amperes. A service disconnect must be provided between the generator and the power source.

(c) Starters greater than 50 Hp shall be soft-start or VFD, and shall be reviewed by the DISTRICT on a case by case basis.

(d) The alarm circuits shall activate an audible alarm signal, a flashing alarm light on top of the motor control center, and the SCADA Telemetry. Silence and test pushbuttons shall be provided for the alarm circuits. Alarm shall be activated by the failure of either pump, moisture in pump oil chamber, pump motor over temperature, high-water and low water. Circuits as recommended by the submersible motor manufacturer shall be used to sense moisture in the oil chamber. Detection of moisture or motor over-temperature shall cause the motor to be taken out of service which shall be restarted by only manual means.

(e) Control circuits shall operate at 120 volts from a breaker-protected control transformer. Devices for each motor shall include a hand-off-automatic selector switch, an elapsed time meter, and a current transformer driven ammeter. A phase failure/phase reversal relay shall be furnished to remove all pumps from service. The relay shall operate its voltage if any phase drops below 85 percent of nominal voltage. Drop out point shall be adjustable over a range of at least 80 to 95 percent of nominal. Pump operation which is interrupted because of power failure shall re-start automatically upon power restoration. Pilot lights shall be furnished to indicate phase failure, high water, and moisture seal failure.

(1) Indicating lights shall be furnished for the following functions for each pump:

- High Temperature Shutdown
- Running
- Automatic
- Manual
- Seal Failure

(2) Elapsed Time Indicators: Six digit elapsed time indicators (non-reset type) shall be connected to each motor starter to indicate the total running time of each pump in "hours" and "tenths of hours".

(3) Equipment Marking: A permanent corrosion resistant name plate shall be attached to the control and include the following information:

- Equipment serial number
- Supply voltage, phase and frequency
- Current rating of the minimum main conductor
- Electrical wiring diagram number
- Motor horsepower and full load current
- Motor overload heater element
- Motor circuit breaker trip current rating
- Name and location of equipment manufacturer

(f) The motor control center shall be assembled in a stainless steel NEMA 4 enclosure suitable for mounting on the support structure. Enclosure shall feature a hinged outer door with key operated cylinder lock and a hinged inner door containing all control devices. All breakers, overload resets, etc. shall be operable without opening the inner door. All control devices shall be identified with an engraved laminated nameplate permanently attached. Internal wiring shall be permanently identified with wire and terminal number and shall be grouped and tied to present a neat appearance. The complete motor control center shall be suitable for use on the voltage shown for the pump motors elsewhere in these Specifications and shall comply with all requirements of the National Electrical Code or any state or local codes or ordinances. The support structure shall be made of stainless steel or aluminum and approved by the DISTRICT.

9.14 SCADA Telemetry System

(a) The SCADA (Supervisory Control and Data Acquisition) telemetry system shall be supplied by a reputable company experienced in installation of SCADA systems. The DISTRICT's SCADA/PLC (Programmable Logic Controller) department shall approve the company doing this work.

(b) A high speed internet connection (cable or Digital Subscriber Line) shall be provided to the Pump Station site for future/backup communication needs. Downstream speed shall be a minimum of 1.5 Megabits per second (Mbps), upstream speed shall be a minimum of 384 Kbps.

(c) Primary communication for the SCADA system shall utilize a Cellular Modem (Cellular Gateway). The modem shall be heavy duty, rated for continuous use and exterior applications. Communications protocols shall be the latest standard, as approved by the DISTRICT.

SCADA Telemetry System - General Requirements

A new telemetry system shall be provided to collect status and alarm conditions at the remote stations and transmit same to the mission communications central control station for displaying, alarming, annunciation, storing and processing into reports.

The system shall be composed of the following basic components:

A. Unique field gathering devices and circuits

B. RTU (Remote Terminal Unit) enclosure, Cellular Modem (Cellular Gateway) for communication, and utility pole if required

The installer shall provide for the supply, installation certification, adjustment, and start-up of a complete, coordinated system which shall reliably perform the specified functions. The Installer shall coordinate work to ensure that:

A. All components of the various systems are installed.
B. Each system is complete including items not specifically addressed in these specifications but required to achieve a fully complete system.
C. The proper type, size and number of wires with their conduits are provided for all components and systems.
D. Proper electric power circuits including wire and conduit are provided for all components and systems.
E. Modifications to the system or inter system components are made to achieve the correct end function.
F. The finished systems have been coordinated to produce function and control installation stability and reliability.

CONTROL AUXILIARIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1) Pilot devices:
a. Selector switches.
b. Pushbuttons
c. Indicating lights
d. Combination selector switch/indicator light
2) Relays/timers:
e. Control relay.
f. Time delay relays.
3) Termination equipment:
g. Terminal blocks.
h. Fuse holders.
4) Power supplies:
i. DC power supplies
j. Isolation transformers
5) Voltage surge protection devices
6) Running time indicator

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURE

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable articles below are acceptable.

B. Provide similar components from the same manufacturer for uniformity

of appearance, operations, and maintenance.

3.1 PILOT DEVICES

A. Selector Switches:
1) Acceptable manufacturers:
a. Cutler Hammer
b. Allen Bradley
c. Square D
2) Design and fabrication:
a. Heavy-duty type corrosion resistant
b. NEMA 4X.
c. Rotary cam units conforming to NEMA ICS 2-216.22
d. Mounting hole: 30.5 mm.
e. Supply switches having number of positions required with contact blocks to fulfill functions shown and specified.
f. UL listed.
g. Maintained contact type.
h. Extended or glove type lever.
i. Black colored operators.
j. Designed with cam and contact block with approximate area of 2 square inches
k. Legend plate marked per Contract Documents.
l. Contact block requirements:
1) Dry and indoor locations: Standard contact blocks rated for 10 amps continuous current.
2) Wet or outside locations: Hermetically sealed contact blocks.

B. Pushbuttons:
1) Acceptable manufacturers:
a. Cutler Hammer
b. Allen-Bradley
c. Square-D

2) Design and fabrication:
a. Heavy-duty type, corrosion resistant
b. Oiltight, NEMA 4X.
c. Conforming to NEMA ICS 2-216.22
d. Mounting hole: 30.5 mm.
e. UL listed.
f. Emergency stop pushbuttons to have mushroom head operator and maintained contact.

3) Non-illuminated type
a. Momentary contact with necessary contact blocks.

b. Molded, solid color melamine buttons.
c. Standard flush operators with full shroud
d. Red colored buttons for START or ON and Green color for STOP or OFF.
e. Appropriate contact blocks to fulfill functions shown or specified.

4) Contact block requirements:
a. Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
b. Wet or outside locations: Hermetically sealed contact blocks.
c. Legend plate marked per Contract Documents.

5) Illuminating type:
a. Momentary contact with necessary contact blocks.
b. Serves as both pushbutton control and indicating light
c. Red colored lenses for start or on and Green for STOP or OFF.
d. Resistor-type full voltage light unit with lens and panel gasket
e. Legend plate marked per Contract Documents.
f. Appropriate contact blocks to fulfill functions shown or specified.

C. Indicating Lights
1) Acceptable manufacturers:
a. Cutler Hammer
b. Allen-Bradley
c. Square-D

2) Design and fabrication:
a. Heavy duty type, corrosion resistant..
b. Oiltight, NEMA 4X.
c. Type allowing replacement of bulb without removal from control panel
d. UL listed.
e. LED
f. Legends marked per Contract Documents.
g. Nominal 2 IN SQ face.
h. Mounting hole: 30.5 mm.
i. Push-to-test indicating lights
j. Plastic lens
k. Color code lights as follows:
1) Red: ON or running; valve open
2) Amber: Standby; auto mode; ready.
3) Green OFF or stopped; valve closed.
l. Legend plate engraved for each light.

4.1 RELAYS/TIMERS

A. Control Relays:

1) Acceptable manufacturers:

a. Idec
b. Potter & Brumsfield
c. Allen-Bradley

2) Design and fabrication:

a. Plug-in general purpose relay
b. Blade connector type
c. Switching capacity: 10 A.
d. Contact material: Silver cadmium oxide.
e. Provide relays with a minimum of 2 DPDT contacts.
f. Coil voltage: 120 Vac or 24 Vdc.
g. Relay sockets are DIN rail mounted.
h. Internal LED indicator is lit when coil is energized.
i. Clear polycarbonate dust cover with clip fastener
j. Check button.
k. Temperature rise
    1) Coil: 85 DegF max.
    2) Contact: 65 DegF max.
l. Insulation resistance: 100 Meg min.
m. Frequency response: 1800 operations/hour.
n. Operating temperature: -20 to +150 DegF.
o. Life expectancy:
    1) Electrical: 500,000 operations or more.
    2) Mechanical: 50,000,000 operations or more.
p. UL listed or recognized.

B. Time Delay Relays:

1) Acceptable manufacturers:

a. Eagle Signal Controls.
b. Idec
c. Omron

2) Design and fabrication:

a. Heavy-duty
b. Solid-state construction
c. External adjusting dial
d. Auxiliary relays as required to perform functions specified or shown on the Drawings.
e. Operates on 117 Vac (±10 percent) power source
f. Contact rating: Al50 per NEMA ICS 2-125.
g. Furnish with "on" and "timing out" indicators

C. Intrinsically Safe Relays:
1) Acceptable Manufacturers:
a. Pepper & Fuchs KFAS-SR2-EX2
b. Or equal
2) The intrinsically safe relays shall have the following features:
a. 120 VAC control voltage
b. SPST, 120 VAC, lOA contact.
c. Plug-in style relay, DIN-rail mounted.
d. UL listed for Class I, Division I locations.
e. Dual channel

5.1 TERMINATION EQUIPMENT

A. Terminal Blocks:
1) Acceptable manufacturers:
a. Phoenix Contact
b. Allen-Bradley

2) Design and fabrication:
a. Modular type with screw compression clamp
b. Screws: Stainless steel.
c. Current bar: Nickel-plated copper allow.
d. Thermoplastic insulation rated for -40 to +90 DegC
e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
f. Install end sections and end stops at each end of terminal strip.
g. Install machine-printed terminal markers on both sides of block.
h. Spacing: 6 mm.
i. Wire size: 22-12 AWG.
j. Rated voltage: 600 V.
k. Din rail mounting.
l. UL listed

3) Standard-type block:
a. Rated current: 30 A.
b. Color: Gray body.

4) Bladed-type block:
a. Terminal block with knife blade disconnect which connects or isolated the two (2) sides of the block.
b. Rated current: 10 A.
c. Color:
1) Panel control voltage leaves enclosure - normal: Gray body, orange switch.
2) Foreign voltage entering enclosure: Orange body, orange switch.

5) Grounded-type block:
a. Electrically grounded to mounting rail
b. Use to terminal ground wires and analog cable shields.
c. Color: Green and yellow body.

B. Fuse Holders:
1) Acceptable manufacturers:
a. Phoenix Contact
b. Allen-Bradley

2) Design and fabrication:
a. Modular-type with screw compression clamp
b. Screws: Stainless steel.
c. Current bar: Nickel-plated copper alloy.
d. Thermoplastic insulation rated for -40 to + 105 DegC.
e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
f. Blocks can be ganged for multi-pole operation.
g. Install end sections and end stops at each end of terminal strip.
h. Install machine-printed terminal markers on both sides of block.
i. Spacing: 9.1 mm.
j. Wire size: 30-12 AWG.
k. Rated voltage: 300 V.
l. Rated current: 12 A.
m. Fuse size: 114 x 1-1/4.
n. Blown fuse indication.
o. DIN rail mounting.
p. UL listed.

C. Terminal blocks and fuse holders to be provided by the same manufacturer.

6.1 POWER SUPPLIES

A. DC Power Supplies:
1) Acceptable manufacturers:
a. Sola Hevi-Duty
b. Phoenix Contact
c. PULS
2) Design and fabrication:
a. Converts 120 Vac input to DC power at required voltage.
b. DIN rail mount with enclosure (i.e., not open frame).
c. Switching type
d. AC input: 120 Vac +/-15 percent, nominal 60 Hz.
e. Efficiency: Minimum 86 percent.

f. Rated mean time between failure (MTBF): 500,000 HRS.
g. Voltage regulation:
h. Static: Less than 1.0 percent Vout·
i. Dynamic: +/-2 percent Vout overall.
j. Output ripple/noise: Less than 100 mV peak to peak (20 MHz).
k. Overload, short circuit and open circuit protection.
l. Temperature rating: 0 to 60 DegC full rated, derated linearly to 50 percent at 70 DegC.
m. Humidity rating: Up to 90 percent, non-condensing.
n. LED status indication for DC power

7.1 RUNNING TIME INDICATORS

A. Acceptable Manufacturer:
1) Eagle Signal Controls

B. Design and Fabrication:
1) Six-digit wheels including a 1/10 digit
2) Non-reset type
3) Time range in hours
Automatic recycle at zero.
4) Accuracy: 1 percent
5) Sealed against dirt and moisture
6) Tamperproof

PART 3 - EXECUTION

8.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

RTU ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

2.1 QUALITY ASSURANCE

A. Referenced Standards:
1) American National Standards Institute (ANSI).
2) ASTM International (ASTM):
3) B75, Standard Specification for Seamless Copper Tube.
4) National Electrical Manufacturers Association (NEMA):
5) 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
6) ICS 4, Industrial Control and Systems: Terminal Blocks.
7) National Fire Protection Association (NFPA):
8) 70, National Electrical Code (NEC):

9) Article 409, Industrial Control Panels
10) Underwriters Laboratories, Inc. (UL):
11) 508A, Standard for Safety Industrial Control Panels

B. Miscellaneous:
1) Approved supplier of Industrial Control Panels under provisions of UL 508A.
a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
b. Control panel(s) without an affixed UL 508A label shall be rejected and sent back to the Contractor's factory.

3.1 DEFINITIONS

A. The term "panel" refers to control panels or enclosures listed in the schedule included in this Specification Section.

B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.

C. Intrinsically Safe:
1) A device, instrument or component that will not produce sparks or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture
2) Designed such that electrical and thermal energy limits inherently are at levels incapable of causing ignition

D. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire

E. Instrumentation Cable:
1) Multiple conductor, insulated, twisted or untwisted, with outer sheath.
2) Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad), and is used for the transmission of low current or low voltage signals.

F. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation

G. Programmable Logic Controller (PLC): A specialized industrial computer using programmed, custom instructions to provide automated monitoring and control functions by interfacing software control strategies to input/output devices.

H. Remote Terminal Unit (RTU): An industrial data collection device designed for location at a remote site, that communicates data to a host system by using a Cellular Modem (Cellular Gateway).

I. Input/Output (I/O): Hardware for the moving of control signals into and/or out of a PLC or RTU.

J. Supervisory Control and Data Acquisition (SCADA): Used in process control applications, where programmable logic controllers (PLCs) perform control functions but are monitored and supervised by computer workstations.

K. Highway Addressable Remote Transducer (HART): An open, master-slave protocol for bus addressable field instruments.

L. Digital Signal Cable: Used for the transmission of digital communication signals between computers, PLCs, RTUs, etc.

M. Uninterruptible Power Supply (UPS): A backup power unit that provides continuous power when the normal power supply is interrupted.

N. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20ma DC analog signals.

4.1 SUBMITTALS

A. Shop Drawings:

1) See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2) Prepared with computer aided design (CAD) software
3) Printed on 11 by 17 IN sheets
4) Drawings shall include a title block containing the following:
   a. Plant or facility name where panel(s) are to be installed.
   b. Drawing title
   c. Drawing number
   d. Revision list with revision number and date
   e. Drawing date
   f. Drawing scale
   g. Manufacturer name, address, and telephone number
5) Cover sheet for each drawing set shall indicate the following:
   a. Plant or facility name
   b. Project name
   c. Revision number
   d. Issue date
6) Table of contents sheet(s) shall indicate the following for each drawing in the set:

a. Drawing number
b. Drawing title
c. Sheet number

7) Legend and abbreviation sheet shall indicate the following:
a. Description of symbols and abbreviations used
b. Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.

8) Bill of Material for each panel shall include the following component information:
a. Instrument tag number
b. Quantity
c. Functional name or description
d. Manufacturer
e. Complete model number.
f. Size or rating.

9) Panel exterior layout drawings to scale and shall indicate the following:
a. Panel materials of construction, dimensions, and total assembled weight.
b. Panel access openings
c. Conduit access locations
d. Front panel device layout.
e. Nameplate schedule:
1) Nameplate location
2) Legend which indicates text, letter height and color, and background color
f. Alarm annunciator window engraving schedule
g. Layouts of graphic panels or mosaic displays

10) Panel interior layout drawings shall be drawn to scale and shall indicate the following:
a. Sub-panel or mounting pan dimensions.
b. Interior device layouts
c. Panel general arrangement layouts
d. Wire-way locations, purpose, and dimensions.
e. Terminal strip designations
f. Location of external wiring and/or piping connections
g. Location of lighting fixtures, switches and receptacles

11) Wiring diagrams shall consist of the following:
a. Panel power distribution diagrams.
b. Control and instrumentation wiring diagrams
c. PLC I/O information:
1) Model number of I/O module
2) Description of I/O module type and function
3) Rack and slot number
4) Terminal number on module

5) Point or channel number

6) Programmed point addresses.
7) Signal function and type.

d. Wiring diagrams shall identify each wire as it is to be labeled.

B. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.

C. Electrical load calculations for each panel:
1) Total connected load.
2) Peak electrical demand for each panel

D. Climate control calculations for each panel
1) Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.

E. Miscellaneous:
1) Record Drawings:
2) Updated panel drawings delivered with the panel(s) from the Contractor's factory.
3) Drawings shall be enclosed in transparent plastic and firmly secured within each panel.

F. Operation and Maintenance Manuals:

PART 2 - PRODUCTS

5.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1) Enclosures:
a. Hoffman Engineering Co.
b. Rittal
2) Panel heaters:
a. Hoffman Enclosures, Inc.
b. Rittal
3) Internal corrosion inhibitors:
a. Hoffman Enclosures, Inc.; Model A-HCI
b. Northern Technologies International Corporation (NTIC); Model Zerust VC
c. Cortec Corporation; Model VpCl Emitting Systems

B. Submit request for substitution to MSD SCADA Department.

6.1 ACCESSORIES

A. Panel Nameplates and Identification:

1) Panel Nameplates shall be durable and constructed of stamped aluminum or similar. They shall be weatherproof and UV resistant, and shall be permanently affixed to the respective equipment.

7.1 FABRICATION

A. General:

1) Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.

2) Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents.

3) Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.

4) Panel(s) shall be completely assembled at the Contractor's factory.

a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.

5) Painting:

a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted.

1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.

2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.

3) Utilize solvent or chemical methods to clean panel surfaces.

4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.

5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.

6) Bake powder coating at high temperatures to bond coating to enclosure surface.

a) Panel interior shall be white with semi-gloss finish.

b) Panel exterior shall be ANSI #61 gray with flat finish.

7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 1 or NEMA 12 rated panels.

Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.

6) Finish opening edges of panel cutouts to smooth and true surface conditions.

a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.

7) Panel shall meet all requirements of UL 508A.

a. If more than one (1) disconnect switch is required to disconnect all power within a panel or enclosure, provide a cautionary marking with the word "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one (1) disconnect switch required to de-energize the equipment before servicing."

8) Provide control panel in accordance with NFPA 70, Article 409.

a. In the event of any conflict between NFPA 70, Article 409 and UL 508A, the more stringent requirement shall apply.

9) All control panels shall have inner and outer door with any pilot lights, switches, etc. mounted on the inner door.

B. Free-Standing Panels:

1) Welded construction

2) Completely enclosed, self-supporting, and gasketed dust tight

3) Rolled lip around all sides of enclosure door opening.

4) Seams and comers welded and ground smooth to touch and smooth in visual appearance.

5) Full height, fully gasketed flush pan doors

6) Full length piano hinges rated for 1.5 times door plus instrument weight.

7) Doors with keyed alike locking handles and three-point catch.

8) Appropriate conduit, wiring, and instrument openings shall be provided.

9) Lifting eyebolts to allow simple, safe rigging and lifting of panel during installation.

C. Wall Mounted Panels:

1) Seams continuously welded and ground smooth.

2) Rolled lip around all sides of enclosure door opening.

3) Gasketed dust tight.

4) Three-point latching mechanism operated by oil tight key-locking handle

5) Key doors alike

6) Continuous heavy GA hinge pin on doors.

a. Hinges rated for 1.5 times door plus instrument weight.

7) Front full opening door.

8) Brackets for wall mounting.

D. Internal Panel Wiring:

1) Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip.

a. Route wiring within the panel in wire-duct neatly tied and bundled with tie wraps.

b. Follow wire-duct manufacturer's recommended fill limits.

c. Wire-duct shall have removable snap-on covers and perforated

walls for easy wire entrance.

d. Wire-duct shall be constructed of nonmetallic materials with rating in excess of the maximum voltage carried therein.

2) Wiring shall be installed such that if wires are removed from one (1) device, source of power will not be disrupted to other devices.

3) Splicing and tapping of wires permitted only at terminal blocks.

4) Wire bunches to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire.

a. Protect bend area with sleeve.

5) Arrange wiring neatly, cut to proper length, with surplus wire removed.

a. Arrange wiring with sufficient clearance.

b. Provide abrasion protection for wire bundles that pass through openings or across edges of sheet metal.

6) AC circuits shall be routed separate from analog signal cables and digital signal cables.

a. Separate by at least 6 IN, except at unavoidable crossover points and at device terminations.

7) Provide at least 6 IN of separation between intrinsically safe devices and circuits and non-intrinsically safe devices and circuits.

8) Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.

9) Conductors for AC and DC circuits shall be type MTW stranded copper listed for operation with 600 V at 90 DegC.

a. Conductor size shall be as required for load and 16 AWG minimum.

b. Internal panel wiring color code:

1) AC circuits:

a) Power wiring: Black.

b) Control interconnections: Yellow.

c) Neutral: White.

d) Ground: Green.

2) Low voltage DC circuits:

a) Power wiring: Blue-positive, blue/white - negative

b) Control interconnections: Violet.

3) Foreign voltage circuits: Pink.

4) Annunciator circuits: Red.

5) Intrinsically safe circuits: Orange.

10) Analog signal cables shall be of 600 V insulation, stranded copper, twisted-shielded pairs

a. Conductor size: 18 AWG minimum.

b. Terminate shield drain conductors to ground only at the control panel end of the cable.

11) High precision 250 ohm resistors with 0.25 percent accuracy shall be used where 4-20 mA DC analog signals are converted to 1-5 Vdc signals.

a. Resistors located at terminal strips.

b. Resistors terminated using individual terminal blocks and with no other conductors.

c. Resistor leads shall be un-insulated and of sufficient length to allow test or calibration equipment (e.g., HART communicator, loop calibrator) to be properly attached to the circuit with clamped test leads.

12) Analog signals for devices in separate enclosures shall not be wired in series.

a. Loop isolators shall be used where analog signals are transmitted between control enclosures.

13) Wire and cable identification:

a. Wire and cables numbered and tagged at each termination.

b. Wire tags:

1) Slip-on, PVC wire sleeves with legible, machine-printed markings.

2) Adhesive, snap-on, or adhesive type labels are not acceptable.

c. Markings as identified in the Shop Drawings.

E. Grounding Requirements:

1) Equipment grounding conductors shall be separated from incoming power conductors at the point of entry.

2) Minimize grounding conductor length within the enclosure by locating the ground reference point as close as practical to the incoming power point of entry.

3) Bond electrical racks, chassis and machine elements to a central ground bus

a. Nonconductive materials, such as paint, shall be removed from the area where the equipment contacts the enclosure.

4) Bond the enclosure to the ground bus.

a. It is imperative that good electrical connections are made at the point of contact between the ground bus and enclosure.

5) Panel-mounted devices shall be bonded to the panel enclosure or the panel grounding system by means of locknuts or pressure mounting methods.

6) Sub-panels and doors shall be bonded to ground.

F. Termination Requirements:

1) Wiring to circuits external to the panel connected to interposing terminal blocks.

2) Terminal blocks rigidly mounted on DIN rail mounting channels.

3) Terminal strips located to provide adequate space for entrance and

termination of the field conductors.

4) One (1) side of each strip of terminal blocks reserved exclusively for the termination of field conductors.

5) Terminal block markings:

a. Marking shall be the same as associated wire marking.

b. Legible, machine-printed markings

c. Markings as identified in the shop drawings.

6) Terminal block mechanical characteristics and electrical characteristics shall be in accordance with NEMA ICS 4.

7) Terminal blocks with continuous marking strips.

a. Each terminal block shall be identified with machine printed labels.

8) Terminals shall facilitate wire sizes as follows:

a. 120 Vac applications: Conductor size 12 AWG minimum.

b. Other: Conductor size 14 AWG minimum.

9) Analog signal cable shield drain conductors shall be individually terminated.

10) Install minimum of 20 percent spare terminals.

11) Bladed, knife switch, isolating type terminal blocks where control voltages enter or leave the panel

12) Fused terminal blocks shall be used in the following circuits:

a. Control voltage is used to energize a solenoid valve.

b. DC power is connected to 2-wire, loop-powered instruments.

13) Fused terminal blocks shall be provided with blown fuse indicators.

14) When control circuits require more than one (1) field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one (1) field conductor per terminal block.

15) DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.

16) Connections to devices with screw type terminals shall be made using spade-tongue, insulated, compression terminators.

G. Component Mounting and Placement:

1) Components shall be installed per manufacturer instructions.

2) Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical.

3) Front panel devices shall be mounted within a range of 40 to 70 IN above the finished floor, unless otherwise shown in the Contract Documents.

4) PLC and I/O rack installation:

a. Located such that the LED indicators and switches are readily visible with the panel door open.

b. Located such that repair and/or replacement of component can be accomplished without the need to remove wire terminations or

other installed components.

5) Locate power supplies with sufficient spacing for circulation of air.

6) Where components such as relays and other electromagnetic devices are installed within the same enclosure as the PLC system components, provide a barrier of at least 6 IN of separation between the "power area containing the electromagnetic devices" and the "control area".

7) Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws.

a. Fastening devices shall not project through the outer surface of the panel enclosure.

8) Excess mounting space of at least 20% for component types listed below to facilitate future expansion:

a. Fuse holders.
b. Circuit breakers
c. Control relays.
d. Time delay relays.
e. Intrinsically safe barriers and relays

9) Components installed on sub-panels shall be provides with a minimum spacing between component and wire duct of 1 IN.

a. Minimum of 2 IN separation between terminal strips and wire ducts

10) Pneumatic tubes and appurtenances:

a. Connect panel air piping and tubing penetrations with bulkhead fittings.
b. Pneumatic control tubing shall be 114 IN OD.
1) Tubing material: Either soft annealed ASTM B75 copper or flame-resistant polyethylene.
2) Main headers within panels shall be minimum 1 inch.
3) Compression-type pressure fittings
4) Equip panel instrument leads with ball type isolation valve.
5) Route tubing neatly and mount securely.
6) Do not route tubing in front of or in wire ducting.
7) Code terminal plates
8) Pneumatic devices shall be served by a dual function filter regulator.

H. Power Distribution:

1) Main incoming power circuits shall be protected with a thermal magnetic circuit breaker.

a. Limit load to maximum of 80 percent of circuit breaker rating.

2) Component types listed below shall be individually circuit breakers so that they may be individually de-energized for maintenance:

a. PLC power supply modules.
b. Flow Instruments
c. Cellular Modem (Cellular Gateway)

d. HMI
e. Heater
f. Fan, etc.

3) Each control panel with PLC/RTU components shall be furnished with power protection in the form of a double conversion UPS.

4) Equip each panel with necessary power supplies with ratings required for installed equipment and with minimum 25 percent spare capacity.

5) Constant voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.

I. Internal Panel Lighting and Service Receptacles:

1) Panels less than or equal to 4 FT wide:
   a. One (1) electrical GFCI duplex receptacle.
   b. One (1) compact fluorescent light fixture with manual switch(es).
2) Panels or panel faces greater than 4 FT wide:
   a. One (1) duplex electrical GFCI receptacle per 6 FT of length.
   b. Continuous fluorescent lighting strip with manual switches

J. Environmental Controls:

1) Indoor panels located in a designated electrical room or control room:
   a. Thermostat controlled cooling fans with exhaust louvers if required to maintain temperature inside panel(s) below the maximum operating temperature rating of the internal components.
   b. Internal corrosion inhibitors
2) Outdoor panels:
   a. Thermostat controlled heaters to maintain temperature at 32 DegF minimum inside the panels.
3) Environmental control components:
   a. Panel heaters:
      1) Thermostat controlled.
      2) Fan driven
      3) Components mounted in anodized aluminum housing.
      4) Designed for sub-panel mounting
      5) Powered from 120 Vac and protected with a dedicated circuit breaker.
   b. Cooling fans and exhaust packages:
      1) Cooling fan with louver or grill and replaceable filter
      2) Designed to be mounted within a panel cutout to provide positive airflow through the panel
      3) Cooling fan and exhaust louvers shall be designed and listed to maintain a NEMA 12 enclosure rating.
      4) Fitted with replaceable, high-density foam or synthetic fiber

5) Cooling fan controlled with a separately mounted thermostat with bi-metal sensor and adjustable dial for temperature setting.

6) Powered from 120 Vac and protected with a dedicated circuit breaker.

c. Internal corrosion inhibitors:

1) Contains chemical which vaporizes and condenses on surfaces in the enclosure

2) Inhibitor shall be applied in accordance with manufacturer instructions for the enclosure volume.

3) Inhibitor shall be applied in the panel(s) prior to shipment from the Contractor's factory.

8.1 MAINTENANCE MATERIALS

A. Extra Materials:

1) Quantity of 25 percent replacement lamps for each type installed (minimum of 12 of each type).

2) Minimum 12 replacement filters for each type installed.

3) One (1) quart of exterior finish touch-up paint.

4) One (1) complete set of replacement corrosion inhibitors in sealed packages for each panel.

PART 3 - EXECUTION

9.1 FACTORY TESTING

A. Scope: Inspect and test entire panel assembly to verify readiness for shipment.

B. Location: Contractor's factory.

C. Factory Tests:

1) Tests shall be fully documented and signed by the Contractor's factory supervisor.

2) The panel shop shall fully test the control panel for correct wiring.

a. Each I/O point shall be checked by measuring or connecting circuits at the field terminal blocks.

3) Burn-in test: Panel(s) shall be fully energized for a minimum period of 48 HRS.

4) Testing equipment (such as digital multi-meters and analog loop calibrators shall be used as required for testing.

5) The following functions shall be tested as a minimum:

a. Demonstrate functions of the panel(s) required by the Contract Documents.

b. Correctness of wiring from all panel field terminals to all panel components

c. Simulate and test each discrete signal at the field terminal strips.

d. Simulate and test each analog signal using loop calibrators.
e. Correct operation of single-loop controllers (including digital communication to microprocessor based devices).
f. Correct operation of all digital communication devices.
g. Demonstrate online and offline diagnostic tests and procedures.
h. The Contractor shall notify the Engineer in writing a minimum of 15 calendar days prior to the Factory Tests.
1) Engineer has the option to witness all required tests.

6) Make following documentation available to the Engineer at test site during the tests:
a. Contract Documents
b. Factory Demonstration Testing procedures.
c. List of equipment to be testing including make, model, and serial number
d. Shop Drawing submittal data for equipment being tested.

7) Deficiencies shall be corrected prior to shipment from the Contractor's factory.

10.1 INSTALLATION

A. Install free-standing panels on 4 inch high concrete housekeeping pads.
B. Anchor panels in a manner to prevent the enclosure from racking, which may cause the access doors to become misaligned.
C. Obtain approved panel layouts prior to installation of conduits.
D. Install products in accordance with manufacturer's instructions.

SCADA Telemetry System - Specific Requirements

(a) The alarm and input/output signals communicating with the DISTRICT's SCADA system shall be as follows:

Alarm Matrix:

ALARM	DESCRIPTION
Utility Power Failure Alarm	Utility power has failed.
UPS Battery Low Alarm	UPS battery voltage is too low.
Pump 1 Overload Alarm	Pump 1 Motor Overload
Pump 2 Overload Alarm	Pump 2 Motor Overload
Pump 1 Over Temp Alarm	Pump 1 Motor Overtemp
Pump 2 Over Temp Alarm	Pump 1 Motor Overtemp
Pump 1 Seal Failure	Pump 1 Motor Seal
Pump 2 Seal Failure	Pump 1 Motor Seal
Wet Well High Alarm	Wet Well Level High (HydroRanger and/or Float)
Wet Well Low Alarm	Wet Well Level Low (HydroRanger and/or Float)

Generator Running Alarm	Generator Status (Running or Stopped)
Generator Fault Alarm	Generator Status (Fault or OK)
Generator Low Fuel Level (if available)	Generator Status (Fuel low or OK)
Communication Alarm	PLC to PLC Communication Status

Definition of Alarms

1. **Utility Power Failure**
   This alarm is used to signal the SCADA system that the utility power has failed. This is read from the Automation Transfer Switch (ATS) when it is in the utility position and generator position.

2. **UPS Battery Low**
   This alarm is used to signal the SCADA system that the UPS battery is too low. This is read from a relay on the UPS.

3. **Generator Status**
   This alarm is used to signal the SCADA system that the station generator is running. This alarm shall be read from the generator.

4. **Wet Well Level High**
   This alarm is used to signal the SCADA system that the station wet well level is too high. It shall be read from the ultrasonic level indicator and the backup float switch.

5. **Generator Fault**
   This alarm is used to signal the SCADA system that the station generator has a failure and cannot be started automatically. The signal shall be read from the generator control panel.

6. **Pump 1 Failure**
   This alarm is used to signal the SCADA system that the pump has failed. It shall be read from the overload, seal failure or over temperature input on the PLC.

7. **Pump 2 Failure**
   This alarm is used to signal the SCADA system that the Number 2 pump has failed. It has the same conditions as the Number 1 pump.

8. **Low Fuel Level**
   This alarm is used to signal the SCADA system that the generator has a low fuel condition. This alarm is read from the generator.

9. **Communication Alarm**
   PLC logic to check communication with control center PLC. Alarm is generated at the control center PLC.

10. **Unassigned Alarm**
On all stations there shall be at least 3 unassigned alarms allocated for future upgrades.

Station PLC Input and Output Requirements:

The system shall provide adequate inputs and outputs for each site with sufficient spares for future addition of equipment. The following table identifies required I/O:

Analog Inputs	State	Purpose
AI 0	4ma-20ma	Wet Well Level
AI 1	4ma-20ma	Pump 1 Current
AI 2	4ma-20ma	Pump 2 Current
AI 3	4ma-20ma	Mag Meter Flow
Discrete Inputs	**Boolean Value, Contact State, Description**	**Purpose**
Input 0	(0, Open Contact, Utility OK) (,1,Closed Contact, Utility Failure)	Utility Power Fail
Input 1	(0, Open Contact, Battery OK)(,1,Closed Contact, Battery Failure)	UPS Battery Low
Input 2	(0, Open Contact, Pump 1 HOA Not in Auto)(,1,Closed Contact, Pump 1 HOA in Auto)	Pump 1 Auto
Input 3	(0, Open Contact, Pump 2 HOA Not in Auto)(,1,Closed Contact, Pump 2 HOA in Auto)	Pump 2 Auto
Input 4	(0,Open Contact, Pump 1 Not Running)(,1, Closed Contact, Pump 1 Running)	Pump 1 Running
Input 5	(0, Open Contact, Pump 2 Not Running)(,1, Closed Contact, Pump 2 Running)	Pump 2 Running
Input 6	(0, Open Contact, Pump 1 Overload OK)(,1, Closed Contact, Pump 1 Overload)	Pump 1 Overload
Input 7	(0, Open Contact, Pump 2 Overload OK)(,1, Closed Contact, Pump 2 Overload)	Pump 2 Overload
Input 8	(0, Open Contact, Pump 1 Overtemp OK)(,1, Closed Contact, Pump 1 Overtemp)	Pump 1 Over Temp
Input 9	(0, Open Contact, Pump 2 Overtemp OK)(,1, Closed Contact, Pump 2 Overtemp)	Pump 2 Over Temp
Input 10	(0, Open Contact, Pump 1 Seal Failure OK)(,1, Closed Contact, Pump 1 Seal Failure)	Pump1 Seal Failure
Input 11	(0, Open Contact, Pump 2 Seal Failure OK)(,1, Closed Contact, Pump 2 Seal Failure)	Pump 2 Seal Failure
Input 12	(0, Open Contact, Wet Well Level OK)(,1, Closed Contact, Wet Well Level High)	Wet Well High Float
Input 13	(0, Open Contact, Wet Well Level OK)(,1, Closed Contact, Wet Well Level LOW)	Wet Well Low Float
Input 14	(0, Open Contact, Generator OFF)(,1, Closed Contact, Generator Running)	Generator Running

Input 15	(0, Open Contact, Generator OK)(,1, Closed Contact, Generator Fault)	Generator Fault
Input 16	(0, Open Contact, PLC Control Not Enabled)(,1, Closed Contact, PLC Control Enabled)	PLC Control
Input 17	(0, Open Contact, Transfer Switch Not in Utility Position)(,1, Closed Contact, Transfer Switch in Utility Position)	Transfer Switch – Utility
Input 18	(0, Open Contact, Transfer Switch Not in Generator Position)(,1, Closed Contact, Transfer Switch in Generator Position)	Transfer Switch – Generator
Input 19	(0, Open Contact, Rain Pulse OFF)(,1,Closed Contact, Rain Pulse ON)	Rain Bucket
Input 20	(0, Open Contact, Grinder Not Running)(,1,Closed Contact, Grinder Running)	Grinder Running
Input 21	(0, Open Contact, Grinder OK)(,1,Closed Contact, Grinder Fault)	Grinder Fault
Input 22	(0, Open Contact, Not Flooded)(,1, Closed Contact, Flooded)	Flood Switch
Input 23	(0, Open Contact, Pump 1-2 Not Running)(,1, Closed Contact, Pump 1-2 Running)	Pump 1-2 Running
Input 24	(0, Open Contact, Pump 2-2 Not Running)(,1, Closed Contact, Pump 2-2 Running)	Pump 2-2 Running
Input 25	(0, Open Contact, Pump 1-2 OK)(,1, Closed Contact, Pump 1-2 Fault)	Pump 1-2 Fault
Input 26	(0, Open Contact, Pu mp 2-2 OK)(,1, Closed Contact, Pump 2-2 Fault)	Pump 2-2 Fault
Discrete Outputs:	**Boolean Value, Contact State, Description**	**Purpose**
Output 0	Alarm Light Command	Alarm Light (Communication Failure
Output 1	Pump 1 Run Command	Pump 1 Run Relay
Output 2	Pump 2 Run Command	Pump 2 Run Relay
Output 3	PLC Control Enable	PLC Control Relay
Output 4	Communication Failure Reboot Command	Comm Failure Reboot
Output 5	Alarm Buzzer Silence Command	Alarm Buzzer Silence
Output 6	Alarm Indicator Command	Alarm Indicator Relay

Telemetry Use by SCADA

The items listed below shall be displayed on the DISTRICT'S SCADA system.

1. **Wet Well Level**
   The station wet well level shall be displayed on the SCADA system, in feet.

2. **Pump Run Time**

The run times of the pumps shall be individually displayed on the SCADA system. The reading is normally returned to SCADA in 1/10 hour; example: 1425.2 hour. The run time(s) shall be displayed on SCADA in total run time hours and individually resettable to zero from the SCADA system.

9.15 Liquid Level Controls

(a) Level control in the wet well shall be "Milltronics Hydro Ranger Ultrasonic" level controller. Controls shall provide for automatic alternation of the pumps after each pump run cycle. Controls shall allow for lead/lag operation of the pumps. Failure of the duty pump shall cause the standby pump to run. Follow manufacturer user manual for Hydro Ranger set up.

(b) One backup float switch shall be provided for the high water alarm and shall be sealed within a polyurethane ball. A weight shall be provided for the float switch. A single stainless steel bracket shall hold the float switch. Float switches and electrical cable shall be certified by an independent laboratory for Class 1, Groups C and D, Division 1, hazardous locations, as defined by the National Electrical Code. Float switches shall be furnished with sufficient cord to connect to the motor control center and to allow for adjustment.

(c) All controls shall be mounted in strict accordance with the manufacturer's specifications.

9.16 Electrical Wiring

(a) The electrical wiring shall consist of a service pole, service entrance, service disconnect, main breaker, power wiring to pump control panel, power and control wiring to the pumps, grounding system and metering provisions as required by the electric utility. All wiring shall comply with requirements of the National Electrical Code, any state or local codes or ordinances, and the electric utility company. All materials shall be listed by Underwriters Laboratories and shall be new and delivered to the job in its original cartons. All exposed conduits shall be stainless steel minimum, 3/4 inch trade size, meeting UL and ANSI standards. All power and control conductors shall be Class B stranded copper. Power conductors shall be minimum number 12 AWG Type RHH-RHW-USE meeting ICEA Standard S-68-516 or S-66-524. Control conductors shall be minimum number 14 AWG Type THHN. Ground conductors shall be medium soft drawn, stranded copper meeting ASTM Standard B-8. Connectors and terminals shall be solderless compression or pressure type cast connectors. Below grade ground connections shall be exothermically welded. All wiring shall be run in conduit except pump power and control cords within the wet well. All conduits from the wet well to the control panel must be stainless steel and buried at least 18 inches deep. All conduit ends must be sealed watertight in the wet well and at the electrical box. Conduit seals shall be installed above and below the wire trough.

(b) The service pole shall be treated pine, minimum class 4, with at least 20 percent of its length set in earth and firmly tamped. Height, location, and setting depth shall be as required by the electric utility. Metal poles will be approved on a case-by-case basis.

(c) The main breaker shall be an enclosed circuit thermal-magnetic breaker, 3 pole, and 600 volt, labeled as suitable for service equipment. The service shall be protected with a three pole secondary lightning arrestor connected directly to the grounding system.

(d) All wiring methods and materials within the wet well shall comply with code requirements for Class I, Division I, Group C and D areas. Pump power and control cords shall be run from the wet well to the pump control panel underground in conduit at least 18 inches deep. Conduit shall be sealed around the cord inside the wet well in such a manner that the cord and seal may be removed from the conduit system when the pump must be removed for repair.

(e) The grounding system shall consist of bare copper conductors, minimum No. 2 AWG, bonding together the wet well reinforcing steel, the pump rails, metallic piping, the utility company neutral conductor, and a driven ¾ inch x 10 foot copper clad ground rod at the service pole. Grounding bushings shall be used at all conduit terminations in enclosures to insure ground continuity.

(f) The CONTRACTOR shall coordinate the installation with the electric utility. The CONTRACTOR shall furnish and/or install metering provisions as required by the utility, verify service voltage, and include in his bid any charges from the utility for providing service to the station.

(g) Electrical conduit shall be SCH 80 PVC below ground and on the SCADA pole. All other above ground conduit and penetrations into the wet well shall be stainless steel or aluminum.

(h) The electric meter shall be located outside of the fenced area on an appropriate support structure in accordance with the requirements of the electric utility. Disconnects shall be located within the secured fenced site.

(i) Area lighting and hot box shall derive their power from the metered power supply for the station. Under no circumstances shall two accounts be allowed for a station such as a remote hot box installation.

(j) All electrical work and materials shall comply, as a minimum, with the National Electrical Code.

9.17 Hoist

A hoist shall be provided when any piece of equipment is 2,000 lbs. or greater.

9.18 Wet Well Structure

(a) The wet well structure shall consist of a precast concrete manhole or placed concrete of the type and size shown on the Plans. The precast manhole sections shall conform to the DISTRICT's Manhole Specifications. The structure shall be level and all grout work shall be smooth with a steel trowel finish. Solid concrete fillets shall be poured to create a sump in which the pump sits. These fillets shall be in accordance with standard details as far as height and slope but shall be oriented in relation to the pump installation requirements.

9.19 Installation and Erection

(a) Pumps and other equipment shall be erected and installed by competent, skilled mechanics at the exact positions and elevations shown on the Plans.

(b) The CONTRACTOR shall furnish all necessary oil and grease for the operation of the equipment during the initial trial operation.

(c) Anchor bolts shall be type 304 stainless steel, accurately placed in the concrete foundations in their exact position and elevation by the use of templates. All anchor bolt settings shall be carefully checked and embedded to the proper depth per manufacturer.

(d) All equipment and connecting piping shall be installed and supported in such manner that no load from the piping will be carried by the pumps.

(e) The CONTRACTOR shall properly grout each piece of equipment after it has been carefully aligned and leveled with steel wedges. The grout shall be poured so as to completely fill the space between the bottom of the base of the equipment and the top of the foundation. Grout shall be a non-shrinking type.

(f) After installation, the wet well shall be filled with clean water and allowed to stand for 24 hours (minimum) and then the water level shall be measured to determine if leakage has occurred. After satisfactory completion of the hydrostatic test of the wet well, a drawdown test and start-up shall be performed. A factory representative shall be on site for this test. Each pump shall be run through 3 drawdown cycles, measuring drawdown and timing the run to compute pumping rate. Clean water shall be used for the drawdown test. The controls shall be checked for operation in the automatic and manual operation modes. Float switches, if installed, shall be checked for proper elevations and operation. The SCADA system and alarms shall be programmed and checked for proper operation.

9.20 Sewage Pumping Station and Sewage Force Main Piping

(a) All pipe materials shall be first quality with smooth interior and exterior surfaces, free from cracks, blisters, honeycombs and other imperfections, and true to theoretical shapes and forms throughout. All materials shall be subject to the inspection of the ENGINEER at the Plant, project site, or other point of delivery, for the purpose of culling and rejecting materials, which do not conform to the requirements of the Specifications. Rejected materials shall be removed from the project site. Minimum force main pipe size shall be three (3) inches. A copper tracer wire and plastic caution tape shall be buried above the full length of the force main, in accordance with the details.

(b) As particular specifications are cited, the designation shall be construed to refer to the latest revision.

(c) Exposed piping inside the wet well and valve vault shall be flanged joint, ductile iron. Stainless steel bolts shall be used on all flanged joints with anti-seize applied to threads. Flanged pipe shall be manufactured with threaded flanges. Bolt-on or adapter flanges are not acceptable.

(d) Ductile iron pipe with flanged joints shall conform to the requirements of ANSI/AWWA Specification C115/A21.15. Flanges shall conform to the requirements of ANSI/AWWA Specification C115/A21.15.

(e) Fittings for flanged ductile iron pipe shall be of ductile iron. Flanged fittings shall conform to the requirements of ANSI/AWWA Specification C110/A21.10 and shall be suitable for a water working pressure of 250 psi. Flanges shall conform to the requirements of ANSI/AWWA Specification C110/A21.10.

(f) Underground Sewage Force Main piping, inside the pumping station site, (generally inside the fenced area), shall be ductile iron pipe with gasketed, compression type joints, "slip-joints". Ductile iron pipe with slip joints shall conform to the requirements of ANSI/AWWA Specification C151/A21.51. The pipe shall be Class 350. Slip joints shall conform to the requirements of ANSI/AWWA Specification C111/A21.11. Minimum cover shall be 30 inches.

(g) Force Main piping downstream of the pump station valve vault to the point of discharge may be either ductile iron as above specified or C900 PVC, unless the pipe material is specifically called out on the Plans or in the Special Conditions of the Technical Specifications, or otherwise required by the District.

(h) A properly sized and designed Magnetic Flow Meter shall be provided on the force main. It shall be located within a vault properly sized for access and maintenance activities. Length of straight sections of pipe upstream and downstream of the meter shall be as specified by the meter manufacturer.

Magnetic Flow Meters shall be as follows:

1. Acceptable manufacturers:
    a. Krohne
    b. Endress + Hauser
    c. Siemens
2. Design and fabrication:
    a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
    b. High input impedance pre-amplifiers.
        1) Minimum impedance: 10^{10} ohms.
    c. Provide flanged end connections per ASME B16.5 rated for piping system operating and test conditions.
    d. Operating pressure: Equal to or greater than pump station shutoff head.
    e. Grounding requirements:
        1) Nonmetallic or lined pipe:
            a) Inlet and outlet grounding rings of same material as electrode.
        2) Conductive piping:
            a) Conductive path between the meter and the piping flanges.
    f. Provide cable between magnetic flow meter and transmitter of suitable length.
    g. Meter body, liner, and housing shall be suitable for use in and around typical strength residential/commercial wastewater
    h. Pulsed DC magnetic field excitation.
    i. Automatic zero.
    j. Adjustable low flow cutoff.
    k. Minimum signal lock (empty tube zero) to prevent false measurement when tube is empty.
    l. Inaccuracy:
        1) Above 10 percent of range: +/-1.0 percent of rate.
        2) Below 10 percent of range: +/-0.1 percent of range setting.
        3) Add +0.1 percent of range to above inaccuracies for analog outputs.
    m. 4-20 mA DC isolated output into maximum 800 ohms.
    n. Power supply: 115 V AC, 60 Hz, single-phase power.
    o. Indication of flow rate and totalized flow at transmitter.
    p. Meter operable as specified in liquids with 5.0 micro mho/cm or more conductivity.
    q. Meter electronics shall be capable of being removed and replaced without removing flow tube or taking line out of service.
    r. Transmitter electronics shall use microprocessor based architecture and be configured using parameters.

(i) Poly-Vinyl Chloride Pipe (PVC) shall comply with the requirements of

ANSI/AWWA Specification C900, Class 200. The pipe shall bear the National Sanitation Foundation seal for potable water pipe. The pipe shall be of PVC Class 12454-B material, as specified in ASTM 1784. Joints shall be of push-on design, and shall utilize a rubber gasket which shall be designed to insure watertight joints at sustained pressures not less than the pressure class of the pipe. Joints shall be integral with the barrel of the pipe, and shall be manufactured as a homogeneous part of the barrel. No solvent welding or cements shall be used in manufacture of the pipe or construction of the pipe line. Fittings for PVC pipe shall be of mechanical joint ductile iron, and shall comply with the requirements of applicable sections of these Specifications.

(j) Potable water service for wash down shall be copper tubing from backflow preventor to hydrant and shall be soft annealed type K and shall comply with federal specifications WW-T-799.

9.21 Valves

(a) No valve or discharge piping shall be less than 3-inch nominal diameter unless approved otherwise by the ENGINEER. All valves shall be field adjustable for varying discharge heads, and shall have the full opening of the incoming and outgoing pipe diameter.

(b) Plug Valves

(1) Plug valves shall be provided and must allow either or both pumps to be isolated from the force main and the emergency discharge. Valve shall pass 3-inch spherical solids. The plug valve shall be non-lubricated, tapered type. Valve body shall be cast iron or semi-steel. The drip-tight shutoff plug shall be mounted in stainless steel bearings, and shall have a resilient facing bonded to the sealing surface. Valve shall be operated with a single lever actuator providing lift, turn, and reseat action. The lever shall have a locking device to hold the plug in the desired position.

Plug valves shall be installed in a manner to prevent solids from packing into the valve body and restricting the plug movement. Valve shall be installed with flow against the face of the plug in the closed position and the valve on its side with the plug rotating to the top of the pipeline in the open position.

(2) Plug valves shall be suitable for non-shock water working pressures of 200 psi in sizes 12 inches and smaller and 150 psi in sizes 14 to 36 inches. The valves shall provide drip-tight shutoff up to the full pressure rating of the valves in either direction. Valve position indicators shall be provided.

(3) End connections shall be flanged inside the valve vault and mechanical joint if buried. In general, valves installed underground shall have mechanical joints and exposed valves shall be flanged. Flanged

connections shall conform to the requirements of ANSI/AWWA Specification C110. Mechanical joint connections shall conform to the requirements of ANSI Specification A21.11.

(4) Operating means shall be by 2-inch operating nut or by worm-gear operator. Valves 6 inches in size and smaller shall be lever operated and valves 8 inches in size and larger shall be wormgear operated. Wormgear operators shall be enclosed of semi-steel construction. Exposed nuts, bolts, and washers on wormgear operators shall be zinc plated. Valves and operators for underground service shall be sealed to prevent moisture entrance to valve and operator parts. Valves installed underground shall be provided with extension stems and cast iron valve boxes. A sufficient number of standard levers and tee wrenches shall be furnished so that valves in each location are provided with at least one lever or tee wrench, as applicable.

(c) Check Valves

(1) Each pump shall have a full flow swing check valve which passes 3-inch spherical solids. Body to be cast iron, class 30 with flanged ends. Design shall incorporate a cleanout port, external weighted lever, and replaceable valve seat of AISI 304 stainless steel. Valve clapper shall be of molded neoprene with low pressure sealing rings provided at seating surfaces. Hinge pin and external hinge arm shall be stainless steel supported on each end by brass bushings; the sealing bushing shall have double O-rings. Replacement of O-rings shall not require valve removal or access to interior of valve body. Water working pressure to be rated at 175 psi, 350 psi hydrostatic test pressure.

(2) Check valves shall be of the nominal pipe diameter shown on the Plans and shall be so designed that, when open, they will have a clear waterway section of not less than the full nominal inside diameter of the connecting pipe. Check valves shall be as manufactured by Mueller Co., M & H Valve & Fittings Co., or pre-approved equal.

(d) Air/Vacuum Release Valves

(1) A combination air/vacuum valve shall be installed on the sewage force main at the locations shown on the Plans, or where directed by the ENGINEER. Generally an air/vacuum valve shall be installed at all high points, increased down slopes, decreased upward slopes, long ascents, long descents and at long horizontal runs. Air/Vacuum valves shall be Hi-Tech Model 986 or pre-approved equal. The valve body and tapping saddle shall be epoxy coated. The tapping saddle bands shall be stainless steel.

(2) The air/vacuum valve shall be a combination valve designed to exhaust large amounts of air during filling of the force main, to release small amounts of accumulated air during operation, and to admit large amounts of air upon impending vacuum during draining.

(3) The valve shall be float operated and both the air/vacuum and air release functions shall be housed in a single body. The valve body and cover shall be of cast iron conforming to ASTM Specifications A126, Class B. All leverage mechanisms, parts and the spherical float shall be stainless steel, Grade 304. The large and small orifice seats shall be Buna-N and shall be renewable.

(4) The air/vacuum valve shall be supplied with flushing attachments to allow periodic flushing of sediment, grease, and solids. Flushing attachments shall consist of an inlet isolating valve, bronze blow-off and flushing valves, and a minimum of 5 feet of rubber hose with quick disconnects to allow connection to a source of clean flushing water.

(5) All air/vacuum valves shall be installed in a vented manhole, meeting the requirements of Item II of the Specifications. The manhole shall not have a base and shall have cut-outs for the sewage force main. The manhole shall be installed such that no load is applied to the pipe, and shall have 8-inch minimum washed stone in the bottom and up to the springline of the force main. The manhole shall be vented with both a stainless steel vent and a vented cover.

(e) Valve Boxes

(1) Each underground valve installed outside of buildings or structures shall be provided with a valve box. Valve boxes shall be made of cast iron, of the adjustable sliding type, with a shaft diameter of 5¼-inches. The base shall be round or oval. The box shall be provided with an extension section so that, when installed, the cover will be slightly above ground surface.

(2) Valve boxes shall be Figure 4905 as manufactured by Opelika Foundry Company, or comparable boxes as manufactured by the Mueller Company, John Bouchard & Sons, Company, or pre-approved equal.

9.22 Hydrostatic Testing of Sewer Force Main Pipe

(a) After pressure sewer pipe has been laid, backfilled, and the necessary concrete thrust blocks constructed, the pipe shall be subjected to a hydrostatic pressure of 100 psi for a minimum period of 2 hours.

(b) The pipe shall be slowly filled with water and the specified test pressure,

measured at the point of lowest elevation, shall be applied by means of a pump connected to the pipe. The pump, pipe connection, gauges, meters, and other apparatus required for the tests shall be furnished and installed by the CONTRACTOR.

(c) Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, air/vacuum release valves shall be in service.

(d) All exposed pipes, fittings, and joints shall be carefully examined as the force main is installed and during testing. All leakage in joints shall be completely stopped. Any cracked or defective pipes or fittings discovered in consequence of this pressure test, shall be removed and replaced by the CONTRACTOR with sound material in the manner herein before provided and the test shall be repeated until satisfactory to the ENGINEER.

9.23 Water Service to Sewage Pump Stations

(a) Water service to sewage pump station sites shall consist essentially of a water meter, meter yolk, corporation stop, meter box and cover, double check/reduced pressure backflow preventer, water service line, and yard hydrant.

(b) The method and type of tapping the existing water main, the meter, corporation stop, backflow preventer, meter box and couplings shall meet the requirements of the local water authority. The backflow preventer shall be installed above ground in a heated enclosure. See standard backflow preventer detail.

(c) The DISTRICT-maintained portions of water service pipe shall be copper tubing, or polyethylene of the size shown on the Plans.

(1) Copper tubing shall be soft and annealed Type K and shall comply with Federal Specification WW-T-799.

(2) Polyethylene pipe will be allowed in areas outside the fenced compound and under grass. Pipe shall be CTS (copper tubing size) and rated at 200 psi working pressure at 73˚ F. Pipe shall be manufactured with PE 3608 or PE 3710 to SDR 9 wall thickness. Materials and manufacture shall comply with ANSI NSF Standard 61 and meet the requirements of AWWA C 901. Joints shall be minimized. Transitions or couplings shall be compression type brass fittings incorporating a pipe insert and compression seal with integrated joint restraint.

9.24 Corrosion Protection for Exposed Steel or Pipe

(a) All metal surfaces, including pipe, fittings, and valves, which must be protected from weather or corrosion shall have a three part coating system such as Sherwin Williams Exterior Tank System, or approved equal. The surfaces to

which the system is to be applied shall be prepared in accordance with the manufacturer's recommendations.

(b) The first part or application shall be a rust penetrating epoxy pre-primer (Sherwin Williams Macropoxy 920 Pre-Prime or approved equal). After cure, the intermediate coat or base coat (Sherwin Williams Macropoxy HS high solid epoxy or approved equal) shall be applied.

(c) The finish or top coat (High Gloss Sherwin Williams Acrolon 218 HS acrylic polyurethane or approved equal) shall be applied.

(d) Color for pump station piping shall be Sherwin Williams Item Number SW4001 Bolt Brown, or approved equal. Colors for applications other than force main piping shall be submitted to the ENGINEER for approval.

9.25 Sewage Pump Station Site Fencing

(a) Fabric

(1) The fabric shall be composed of 6 foot, 9-gauge galvanized steel wire helically wound to form a continuous chain link fabric having a 2-inch mesh. Top and bottom edges shall have a twisted and barbed finish. The fabric shall be manufactured in accordance with ASTM A-392.

(2) Fabric shall be hot-dipped galvanized after weaving to produce a zinc coating not less in weight than 2.0 ounces per square foot of uncoated wire surface.

(3) Wire in the fabric shall meet minimum breaking strength of 1,290 pounds after galvanizing.

(b) Line Posts

Line posts shall be 2 inches O.D. standard pipe weight 1.76 pounds per foot and

hot galvanized (2 ounces per square foot). Posts to be spaced approximately 10 feet on centers and set a full 2 feet in concrete footings, which are crowned at the ground surface to shed water.

(c) End and Corner Posts

End and corner posts shall be standard hot galvanized (2 oz. per square foot) basic open hearth copper-bearing steel pipe 3 inches O.D. weighing 5.79 pounds per foot, for setting a full 3 feet deep in concrete footings, which are crowned at the ground surface to shed water.

(d) Gate Posts

Gate posts shall be 4-inch diameter, Schedule 40, standard pipe weight 9.11 pounds per foot and concrete filled.

(e) Top Rail

Top rail shall be 1-5/8 O.D. standard pipe weighing 2.27 pounds per foot and hot galvanized (2 oz. per square foot) and shall be furnished in random lengths averaging not less than 20 feet, jointed with extra long pressed steel sleeves, hot galvanized, making a rigid connection but allowing for expansion and contraction.

(f) End and Gate Post Tops

End and gate post tops shall be galvanized malleable iron, drive fitting outside of post to exclude moisture.

(g) Fabric ties

Fabric ties for attaching fabric to line posts or top rail shall be aluminum strip or wire used on top rail every 24 inches and on line posts every 14 inches.

(h) Barbed Wire

The fabric shall be surmounted with 3 strands of barbed wire. Each strand shall consist of two No. 12-1/2 W&M gauge twisted copper-bearing steel line wires, Class 3, hot galvanized, with No. 14 W&M gauge, 4 point barbs spaced not more than 4 inches apart. The barbed wire shall be manufactured in accordance with ASTM A-121.

Barbed Wire Extensions: All intermediate, gate and corner posts shall be equipped with extension arms for supporting barbed wire. The base shall be malleable iron and the extension pressed steel hot galvanized after fabrication. Intermediate arm shall have provision for passing top rail and corner arm casting to have set screw.

(i) Brace and Tension Bands

Brace and tension bands shall be unclimbable beveled edge type with 3/8 inch diameter square shouldered aluminum carriage bolts, non-removable from outside fence.

(j) Bracing

All corner, gate and terminal posts shall be braced by means of 1-5/8 O.D. horizontal compression member, securely attached to terminal and to first line posts with malleable iron fittings, beveled edge bands, and truss braced from first line post to bottom of terminal by 1/2 inch rod and turnbuckle. Corner posts to be so braced in each direction.

(k) Tension Bars

Tension Bars for attaching fabric to terminal posts shall be 3/16 x 3/4 high carbon steel attached to terminal posts by means of beveled edge bands.

9.26 Signage

(a) A weather resistant sign shall be provided in accordance with the sign detail in the Specifications.

9.27 Access Road and Pump Station Site

(a) The pump station access road shall be 12 feet wide (min.) with 2 feet wide shoulders. Maximum centerline grade is 18% unless otherwise approved by the ENGINEER. The road shall be crowned and sloped ¼ inches per foot toward the shoulders. Road shoulders shall be sloped away from road at 5%. The road shall be finished with 8 inches (compacted depth) of ABC stone and 2 inches of SF or RSF 9.5B pavement, as per NCDOT Specifications. Ditches shall be designed and constructed in accordance with N.C. Erosion and Sedimentation Control Manual, latest edition.

(b) Cut slopes shall be sloped at 1 ½ : 1 (max.) Fill slopes shall be sloped at 2:1 (max.).

(c) A turn around shall be constructed adjacent to and outside the fence with a minimum turning radius of 20 feet and a minimum depth of 35 feet.

(d) The pump station site shall be designed such that a minimum 5 feet clearance is provided between the fence and the wet well, valve vault, poles, generator, control panels and any other above ground equipment. The access gate shall be 16 feet wide (min.)

(e) The pump station site, turnaround, and access road shall be paved as specified above. The pump station site shall be paved 1 foot outside the fence, and sloped ¼ inch per foot from the center outward.

(f) The pump station drawings shall include a grading plan showing existing and proposed contours on access road and pump station site, and a detailed site plan showing the location of the wet well, valve vaults, control panels, fence, all underground piping and electrical conduits, light pole, SCADA equipment pole,

and generator in sufficient detail for a surveyor to lay out the site.

(g) Area lighting shall be provided by a pole mounted, downward firing industrial grade LED fixture. The fixture shall provide a minimum output of 20,000 lumens; color temperature shall be 4000K. CRI shall be a minimum of 80.

9.28 Odor Control

(a) The DISTRICT may require odor control systems at pump stations and/or at Air Release Valve locations. These will be considered on a case by case basis. If the developer or owner of a development wishes to install an odor control system at a pump station, they shall contact the DISTRICT to discuss the need and type of equipment. All equipment is subject to review and approval by the DISTRICT.

9.29 Tracer Wires, Tracer Wire Access Boxes, Marker Posts and Marker Tape

(a) All sanitary sewer force mains shall have a solid copper or copper clad steel core tracer wire, specifically manufactured for underground installations, buried on top of the pipe, as per MSD Detail No. 9.20-03. THHN, TNN or uncoated copper wire shall NOT be allowed.

1. The tracer wire shall have a #12 AWG (minimum) solid copper, 7 strand copper conductor wire or steel core, copper clad wire capable of carrying a low voltage (up to 600 volts) current for low voltage applications for locating buried sewer lines and shall meet or exceed ASTM Specifications, UL Standards, and National Electrical Codes (NEC) requirements.

2. For #12 AWG solid copper tracer wire, the insulation shall be a flame retardant, heat, moisture and chemical resistant polyvinyl chloride (PVC) material (60 mil minimum thickness) and shall be PRO-LINE Safety Products CU UF Tracer Wire No. 7430405 or approved equal.

3. For #12 AWG 7 stranded copper tracer wire, the insulation shall be a flame retardant, heat, moisture and chemical resistant polyvinyl chloride (PVC) material (60 mil minimum thickness) and shall be PRO-LINE Safety

   Products CU UF Tracer Wire No. 7431005 or approved equal.

4. For #12 AWG steel core, copper clad tracer wire, the insulation shall be a flame retardant, heat, moisture and chemical resistant polyvinyl chloride (PVC) material (60 mil minimum thickness) and shall be Copperhead High Strength CCS Tracer Wire No. CH1230BHS500 or approved equal.

5. The color of the outer cover shall be “green” in accordance with NC811 and AWWA Uniform Color Code for sanitary sewer uses and shall come in a continuous roll of not less than 1000 feet per roll, unless the distance between tracer wire access boxes, for which the wire is to be installed, is less than

1000 feet; in such cases, the minimum length of the wire on the roll shall be not less than the distance between the terminal boxes plus twenty (20') feet.

6. The tracer wire shall be placed over the sewer pipe or force main pipe after backfilling to 12" to 18" above top of pipe with ABC stone or other acceptable backfill material. After placing tracer wire in pipe trench, the CONTRACTOR shall backfill the remainder of the trench as per MSD Backfill Specifications. In no case shall the tracer wire be disturbed by the backfill process or installation.

7. The tracer wire shall be continuous from the beginning point to the ending point. Should it become necessary to splice this wire, a splice kit/connector capable of handling two (2) to four (4) wires per connection and designated to be "waterproof" shall be provided. Such connector / splice kits shall be Scotchlok DBY by 3M, LV 9000 by SNAPLOC or approved equal.

8. The ends of the tracer wire shall terminate at an approved terminal box (or tracer wire access box) specifically made for assisting in the location of underground tracer wire. The ends of the tracer wire shall be tracer wire affixed to the connector points of the tracer wire access boxes as per the tracer box manufacturer's requirements. Tracer wire access boxes shall be provided at and between each air release valve, air/vacuum valve, combination valve, and the terminal manhole. Tracer wire access boxes shall be those manufactured by VALVCO Inc. or approved equal and capable of supporting and withstanding H20 highway loads.

9. Where the distance between the terminal boxes (tracer wire access boxes) as specified above, exceeds 1000 feet, additional tracer wire access boxes shall be provided and installed so that the distance between any two adjoining boxes does not exceed 1000 feet.

10. The location of all tracer wire access boxes and air release valves shall be marked with a fiberglass utility marker post of not less than 3.75" (w) x 72"

    (L) x 0.125" (t). Marker Posts, as manufactured by Rhino Markers or approved equal, shall be embedded not less than 24 inches, nor more than 36 inches into the ground and shall be green in color conforming to NC811 and AWWA color code requirements for sanitary sewers.

11. Fiberglass Utility Marker Posts shall include the following information either printed directly on the face of the post or on a plastic water resistant label affixed with a waterproof glue or adhesive (see MSD Details for layout):

    - "WARNING" (yellow letters on white background)

- "Sanitary Sewer Force Main" (black letters on white background)
- "Owner – Metropolitan Sewerage District of Buncombe County, NC" (black letters on white background)
- Emergency Phone Number – 828-255-0061 (black letters on white background)
- NC811 "Call Before You Dig" logo - (color on white background)

12. A non-detectable 6.0 mil x 6" (w) pigmented polyethylene utility marker tape, green in color with the wording "Caution – Buried Sewer Line Below" or Caution – Buried Sanitary Sewer Below) imprinted thereon shall be installed in the backfill directly above the sewer force main pipe at a depth of 24" to 36" above the top of the pipe but less than 12" below the finish ground surface. This marker tape shall be PRO-LINE 10434 183 3 or 10434 193 3 or approved equal.

(b) The CONTRACTOR shall be responsible for testing the Tracer Wire System for conductivity after all connections have been made. If the Tracer Wire does not function as intended, the CONTRACTOR shall take appropriate and necessary measures to bring the system into compliance.